REDRAFT

SYNCOAL® REFERENCE PLANT DESIGN REPORT

Submitted to:

Department of Energy
Pittsburgh Technology Center
P. O. 10940
Pittsburgh, PA 15236

Prepared By:

UniField Engineering, Inc.
Western SynCoal® Engineering Team

June 29, 1998

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LEGAL NOTICE

EXECUTIVE SUMMARY

This report presents the Reference Plant Design for a next generation Advanced Coal Conversion Process (ACCP) facility to produce SynCoal®. This process upgrades high moisture, low-rank coals to produce a fuel with improved heating value and reduced sulfur content. It should be noted that the SynCoal® process is protected by U. S. Patents No. 4,725,337 and No. 4,810,258. Use of the process design without a valid process license is not allowed.

To illustrate application of the Design, this report also presents the Preliminary Engineering of a 100-tph processing facility for the Minnkota Power Cooperative, Inc. (MPC), M. R. Young power station located near Center, North Dakota. This particular project would result in development of a facility producing Section 29 qualified SynCoal® for use in Units 1 and 2 at the site.

The report presents engineering criteria and resulting design documents, a description of the process and permitting requirements, a narrative of unit operations, comparison of vendors as well as ultimate vendor selection, process testing, and in conclusion, an analysis of capital costs.

The Reference Plant Design incorporates a vendor-based, modular unit operations approach which enables significant design flexibility to allow processing a variety of coal types at a wide range of through puts. Additionally, a primary goal of the Reference Plant Design was to increase siting flexibility to where the facility could be a stand-alone facility, coupled to a power plant or industrial boiler or even located at the mouth of a mine.

The SynCoal® process is based on the Rosebud SynCoal® ACCP demonstration plant that was nominally designed for 68 tph infeed rate. This facility been operating since 1972 on sub-bituminous coal from the Western Energy mine at Colstrip, Montana. The Reference Plant Design illustrated by the M. R. Young power station varies from the ACCP demonstration plant in the following aspects:

- The Reference Plant Design is sized to upgrade 100 tph of lignite in a two-stage thermal process to reduce its moisture from approximately 36% to 3% whereas the ACCP demonstration plant is able to process 72 tph of Rosebud mine coal with 24-27% moisture.

- The ACCP demonstration plant includes a gravity coal cleaning step whereas it was excluded from the Reference Plant Design.

- The Reference Plant Design uses static bedplate fluid bed units for the Dryer and Reactor. The ACCP demonstration plant uses vibratory fluidized bed units for both stages.

- The Reference Plant Design incorporates indirect cooling in a rotary drum whereas the ACCP demonstration plant utilizes direct cooling in a vibratory fluidized bed.

- The ACCP demonstration plant is a standalone facility that uses natural gas for its source of process heat whereas the Reference Plant Design provides flexibility by providing for use of the lowest cost heat source at the site location.

Capital cost for the illustrated Phase 1 SynCoal® Reference Plant was estimated at $38.5 million with a +/-25% accuracy. The application of the M. R. Young site also anticipated a second phase which would add coal cleaning and stabilization process steps so that the a portion of the production capacity could be used to support market development for regional offsite sales.

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APPENDICES

1.0 INTRODUCTION

This Reference Plant Design report (Report) has been prepared to document an optimized SynCoal® process design approach that allows application of the process to a variety of coals, at a wide range of through puts within several settings. In arriving at the Reference Plant Design presented herein, the following were used as engineering references:

A. The engineering and research data provided by contributors to the Rosebud SynCoal® Advanced Coal Conversion Process (ACCP) demonstration plant in Colstrip, Montana.

B. Experience gained from operating the SynCoal's® ACCP demonstration plant at 72 tph of raw, sub-bituminous coal feedstock from the Western Energy Rosebud mine since 1972. This experience includes engineering and process research invested in optimizing and expanding the demonstration plant.

C. Engineering and market studies conducted by Rosebud SynCoal® Partnership into application of the process at various sites such as Center, North Dakota, Montana Power's Corette Plant in Billings, Montana, and the Bel Aire mine near Gillette, Wyoming.

D. The Center SynCoal® Plant Impact Study produced by Black & Veatch in April 1994 which assessed the feasibility of adding two, 100 tph infeed rate, SynCoal® process trains to the Minnkota Power Cooperative (MPC), M. R. Young Power Station near Center, North Dakota. A copy of the report is provided in Appendix D.

E. A 1993 study conducted by MPC wherein approximately 700 tons of lignite was processed at the ACCP and test fired in Unit 1 of the M. R. Young power station. From August 1995 through mid-November 1995, MPC also test fired SynCoal® produced from Rosebud sub-bituminous coal to test its performance as a deslagging agent in the boiler combustion cyclones.

Based on the potential economic benefits to the M .R. Young power station, this Report illustrates integration of the SynCoal® Reference Plant Design concept into Units 1 and 2 of the station.

This Report was produced through the combined efforts of Western SynCoal®, UniField Engineering and MPC's M. R. Young technical staff. Section 2, of this report, presents a description of the unit operations associated with the Reference Plant Design. Section 3 presents permitting requirements for construction of the facility at the M. R. Young Power Station near Center, North Dakota. Section 4 provides the basis for evaluation and selection of included unit operations for the M. R. Young Power Station facility. Section 5 provides the rationale for process vendor selection, and Section 6 discusses associated testing. In conclusion, Section 7 presents a discussion of the projected capital costs.

1.1 Background

Construction of the SynCoal® demonstration plant located in Colstrip, Montana was completed in 1993 and has since been operating at approximately 72 tph infeed rate with an approximate availability of 75%. Upon achieving success with basic process at demonstration-scale, various engineering studies were undertaken with the goal of refining the process and/or applying it elsewhere. Cumulatively, the studies and ACCP operating experience resulted in an improved approach to plant design and determination of methods to streamline its engineering. The following differences between the ACCP facility and the M. R. Young version of the Reference Plant Design are:

- The M. R. Young version of the Reference Plant Design uses static bedplate fluid bed units for the Dryer and the Reactor. The ACCP uses direct contact processing in vibratory fluid bed units for both stages.

- The M. R. Young version of the Reference Plant Design incorporates indirect cooling in a rotary drum whereas the ACCP utilizes direct cooling in a vibratory fluidized bed.

- The ACCP includes a gravity coal cleaning step whereas it was excluded from the M. R. Young version of the Reference Plant Design.

- The ACCP demonstration plant is a stand-alone facility that uses a natural gas direct-fired heat source for process heat whereas the M. R. Young version of the Reference Plant Design utilizes steam from the power station.

A primary basis in moving away from vibratory fluidized bed technology was twofold: The units installed at the ACCP were the largest ever built for the required process conditions which limited process scale-up potential, and the ACCP units exhibited premature metal and parts failures resulting in increased operating costs and reduced availability. Details of other process changes and supporting data are presented in later sections of this report.

Based on market information gained to date, decisions to apply the process and/or burn the SynCoal® fuel have typically been based on the following economic benefits:

- <u>Substitution for fuels that provide high flame temperatures</u> In applications requiring high flame temperatures such as cement kilns, metallurgical applications and boiler deslagging, SynCoal® has been demonstrated to be lower in cost than liquid or gas fuels while delivering similar performance.

- <u>Substitution for more costly fuel</u> In areas where local coal sources are of insufficient quality to allow use as traditional fuel sources, SynCoal® can provide a cost effective method to upgrade local low rank coals so that importation of more costly fuels can be avoided.

- <u>Potential for tax savings</u> The Reference Plant Design qualifies for Internal Revenue Service Tax Code Section 29 credits for alternative fuels, as granted in a private letter ruling from the Internal Revenue Service for a specific tax-paying entity.

- <u>Increased potential for fuel sales</u>. Due to an ability to compete with gas and liquid fuels, coal producers can increase sales through installation of a SynCoal® process.

In the case of the M. R. Young facility, the primary benefit is replacement of fuel oil used for deslagging cyclone burners. The current value of this benefit would be approximately $1,000,000 to $2,000,000 U. S. dollars per year.

1.2 Design Criteria

The Reference Plant Design was completed using the following criteria as engineering guidelines:

- Maximize process throughput flexibility by using easily scaleable technologies.
- Maximize process applicability by using technologies that are proven successful in a wide variety of applications.
- Maximize siting flexibility to where the facility can stand-alone, be coupled to a power station or industrial boiler or located at the mouth of mine.
- Minimize operating costs by designing for a variety of fuels for supplying process heat.
- Minimize capital cost and engineering time by using common vendor systems.
- Maximize facility reliability through incorporation of knowledge gained by Rosebud SynCoal® Partnership engineers.

Engineering assumptions for the M. R. Young Power Station version of the Reference Plant Design are as follows:

- Plant availability would be designed for 80%, based on a 365-day per year operation, less two annual maintenance shutdowns of 14-day duration each. This is similar to performance demonstrated at the ACCP site.
- The plant would be constructed adjacent to an existing power station which would furnish the following:
    - Main steam at 2,400 psig and 1,000°F, to supply the thermal load with condensate returned to the boiler feed water system.
    - Process gas vents from the SynCoal® facility would be routed to the power plant boiler for incineration.
    - Basic utilities such as:
        - connection to power grid
        - water supplies for fire suppression, potable usage and process usage
        - wastewater treatment
    - Utilization of existing operating and maintenance personnel and facilities where feasible
    - Coordination of environmental permitting.
- Infeed raw lignite would be supplied by the existing Unit 2 raw lignite feed system at approximately 1,000 tph at approximately 36% moisture.

- All process material captured by particulate removal systems would be blended into process streams on a continuous basis.

- A cooling tower, an air compressor and a desiccant drying system would be furnished with the SynCoal® facility.

The M. R. Young Power Station version of the Reference Plant Design was initiated on November 13, 1995. The preliminary design was completed February 1, 1996 and detailed design was approximately 50% completed in April 1997 when this site project was placed on hold.

2.0 PROCESS DESCRIPTION

Section 2.0 presents a description of the SynCoal® process options and the illustrated Reference Plant Design. These descriptions are keyed to engineering documents provided in Appendix A. It should be noted that the SynCoal® process is protected by U. S. Patents No.4,725,337 and No. 4,810,258. Use of the process design without a valid process license is not allowed.

2.1 Process Flow Diagram and Mass and Energy Balances

Referencing drawing 97-813-010, the Process Flow Diagram (PFD) presents the configuration of the proposed Reference Plant facility at the M. R. Young power station. This facility would convert 100 tph of raw lignite coal into approximately 65 tph of SynCoal®. Product and waste process streams on the flowsheet are labeled and correspond with the overall mass and energy balance (M&EB) summary sheet presented as Table 1.

The M&EB was developed using the data sources enumerated in Section 1 and presents normal process flows through the proposed Reference Plant facility. Data obtained from equipment manufacturers was incorporated where appropriate. All process gas streams were estimated from mass and energy equations of state, which defined flow rate, operating conditions and component concentrations for each process step and the overall system.

2.2 Infeed Material Handling

The Lignite preparation system for the M. R. Young Power Station is shown schematically on piping and instrument diagram (P&ID) 97-813-040. Lignite will be diverted to the SynCoal® process at a rate of approximately 1,000 tph by utilizing the existing 2C to 2A belt conveyor transfer point within the Unit 2 building. The diverted lignite will be stored in the SynCoal® building in a bin with a live capacity of approximately 1,800 tons. Lignite will be discharged from this bin at a rate of approximately 100 tph. The speed of lignite discharge will be controlled by a weigh belt. Upon discharge from the bin, lignite will be crushed to minus 3/4 inch with a single roll crusher. After crushing, lignite will be transferred to the Dryer.

All transfer points in the processing building will be equipped with dust collection hoods. The ventilation air from the collection hoods will be processed through a baghouse. Dust collected by the baghouse will be added to the Dryer feed stream as it enters the Dryer.

Specifications for materials handling equipment are provided in Appendix B-1.

2.3 Process Heating

The SynCoal® process can utilize steam or hot gases to supply process heating. Steam heating requires the process to be coupled to a power station or industrial boiler. Drawing 97-813-041 illustrates the utilization of steam process heating. Hot gas heating requires the availability of a hot gas source or the integration of a furnace into the design. Drawing 97-813-011 illustrates the utilization of hot gas for process heating including how a furnace would be integrated into the design should it be needed to provide hot gas. Each heating arrangement will have site specific advantages so selection of the optimum process heating option will require a site specific evaluation.

Evaluation of heating options for the M. R. Young Power Station, which is discussed in Section 4.1, resulted in the selection of steam heating as the most cost effective option for the Reference Plant Design installation at this site. This arrangement allowed utilization of existing steam capacity at the M. R. Young Power Station and integration of the plant into the existing environmental requirements.

Referring to drawings 97-813-010 and 97-813-041, main steam would be supplied at 2,400 psia and approximately 1,000°F to the process heat exchangers. Since required operating temperatures for the Reactor are higher than the Dryer, most of the Main steam would initially be processed by HX-3611 and HX-3612. HX-3611 would remove approximately 17 million BTU per hour from the steam which represents most of the superheat. Any remaining superheat in the steam would then be removed by an attemporator using recycled condensate. The steam would then be utilized in HX-3612 to remove approximately 35 million BTU per hour by condensing the steam. The condensate produced would be at approximately 2,220 psia. The pressure of this condensate is then lowered or flashed in TK-6311 to 2,180 psia to facilitate use of some of the remaining heat by the Dryer condensing heat exchanger.

The balance of the high pressure steam would be processed by Dryer heat exchanger HX-3601. This is also a de-superheating heat exchanger which removes approximately 4 million BTU per hour from the steam. After this heat exchanger, any residual superheat is removed through attemporation with recycled condensate. The de-superheated steam is then combined with the steam generated during the pressure reduction in TK-3611 and utilized in heat exchanger HX-3602. This heat exchanger would condense the steam and remove approximately 25 million BTU per hour. Condensate from TK-3601 and HX-3602 will be further cooled in heat exchanger HX-3603 to remove the final 43 million BTU per hour. After this final cooling stage, condensate would be returned to the boiler feed water system.

This arrangement of heat exchangers provides for the maximum heat removal from the steam. In the case of the Reference Plant Design, this was necessary as the M. R. Young power station was an existing facility and only a limited amount of steam was available. In the event that more steam was available, other heat exchanger systems are possible to complement the boiler and possibly reduce system complexity.

Specifications for process heating equipment are provided in Appendix B-2.

2.4 SynCoal® Process

The Reference Plant Design requires three processing steps convert low rank coal to SynCoal®. These steps are drying, reacting, and cooling. Drawings 97-813-041 through 97-813-044 present the equipment associated with these three steps for the M. R. Young Power Station version of the Reference Plant Design. For the Dryer, a fluidized bed unit was chosen. The basis for this selection is provided by Section 4.2. A fluidized bed unit was also chosen for the Reactor. This selection is discussed in Section 4.3. Direct contact cooling devices were selected for the Coolers which is discussed in Section 4.4.

2.4.1 Dryer

The Dryer system is shown schematically on P&ID 97-813-042. The Dryer utilizes a fluidized bed unit to dry the low rank coal so it can be processed by the Reactor. For the M. R. Young Power Station facility, crushed lignite will be introduced into the Dryer at ambient temperature and approximately 36% moisture and will exit the Dryer at approximately 230°F and 18% moisture. To avoid loss of fluidizing gas, the entrance and exit will utilize double dump valves to provide a gas tight seal. Recirculated drying gases at 550°F will be introduced beneath the bedplate of the Dryer, fluidizing the lignite charge to a bed depth of approximately 54", with an exit fluidizing gas temperature of approximately 230°F. Lignite residence time will be controlled by the temperature of the bed at the outlet of the Dryer. Based upon this temperature, a timer will be adjusted to vary the rate at which the exit double dump valves are actuated.

Gases exiting the Dryer will enter a system of multi-clones, providing entrained particulate removal from the gas prior to entering the Dryer recirculation fan. Gas exiting the Dryer recirculation fan will predominately be recycled to the heat exchanger. Any excess gas will be vented to the vent gas handling system which is described in Section 2.8. Reheating of the gas will utilize three steam heat exchangers as described in Section 2.3.1. Fluidizing gas temperature will be controlled through automatic adjustment of steam flow within the heat exchanger system maintaining a fluid bed dryer inlet gas temperature of 550°F.

To address safety concerns, the Dryer system would be designed with the following equipment:

- Double block and bleed valving would be included on all steam process inputs and vent gas introduction to the boiler systems.
- A spray header dry pipe deluge system in conformance with National Fire Protection Association (NFPA) requirements would be mounted in the Dryer exit plenum to flood the bed with water in the event of a runaway process upset.
- Explosion relief venting for system ducting and the Dryer body in partial conformance with NFPA to provide pressure relief in the event of a fines deflagration. Current ACCP operation has developed a reliable custom relief panel based on positive to negative variations in system operating pressures.

Specifications for the Dryer are provided in Appendix B-3.

2.4.2 Reactor

The Reactor system is shown schematically on P&ID 97-813-043. The Reactor utilizes a fluidized bed similar to the Dryer. Product from the Dryer will be introduced into the Reactor at approximately 230°F and 18% moisture and will exit the Reactor at approximately 550°F and 3% moisture. The Reactor removes some hydrocarbons and sulfur compounds as well as the remaining moisture. To avoid loss of fluidizing gas, entrance and exit will utilize double dump valves to provide a gas tight seal. Recirculated gases at 750°F will be introduced beneath the bedplate of the Reactor, fluidizing the lignite charge to a bed depth of approximately 54", with an exit gas temperature of approximately 410°F. The residence time within the Reactor will be controlled by the temperature of the bed at the outlet of the Reactor. Based upon this temperature, a timer will be adjusted to vary the rate at which the exit double dump valves are actuated.

Gases exiting the Reactor will enter a multi-clone system, providing entrained particulate removal from the gas prior to entering the Reactor recirculation fan. Gas exiting the Reactor recirculation fan will predominately be recycled to the heat exchangers. Any excess gas will be vented to the vent gas collection duct which is described in Section 2.8. Reheating of the gas will utilize two steam heat exchangers as described in Section 2.3.1. Fluidizing gas temperature will be controlled through automatic adjustment of steam flow within the heat exchanger system maintaining a fluid bed dryer inlet gas temperature of 750°F.

To address safety concerns for Reactor system operation and maintenance, the Reactor system would be designed with the following equipment:

- Double block and bleed valving would be included on all steam process inputs and vent gas introduction to the boiler systems.
- A spray header dry pipe deluge system in conformance with National Fire Protection Association (NFPA) requirements would be mounted in the fluid bed reactor exit plenum to flood each reactor bed with water in the event of a runaway process upset.
- Explosion relief venting for system ducting and the Reactor body in partial conformance with NFPA to provide pressure relief in the event of a fines deflagration. Current ACCP facility operation has developed a reliable custom relief panel based on positive to negative variations in system operating pressures.

Specifications for the Reactor are provided in Appendix B-3.

2.4.3 Product Cooling

The cooler system is shown schematically on P&ID's 97-813-044. The cooler utilizes two indirect coolers to reduce the temperature of the SynCoal® below its auto-ignition point. Hot SynCoal® will be introduced into the cooler system at approximately 550°F and 3% moisture and will exit at approximately 150°F and 3% moisture. Cooling is provided by chilled water on the outside of the cooling drum. An inert gas, consisting of nitrogen, will be used to maintain an inert atmosphere within the cooler to eliminate the potential for SynCoal® oxidation.

Water leaving the cooler will be chilled using a direct contact, remotely located cooling tower. The water entering the cooling tower will be approximately 110°F and the water leaving will be 75°F. Estimated makeup water requirement for the cooling tower is 43 gpm. It is estimated that 34 gpm will be lost to evaporation and drift and 9 gpm will be lost to a blowdown stream.

The rotary tube cooler would consist of a series of tube sections positioned alternately at 90° comprising a horizontal drum. The drum would be partially submerged in water in a steel tank in a horizontal position, with water flowing from the product discharge end and leaving at the product input end for counter-current cooling. The drum would rotate slowly, immersing the drum wall in the cooling water bath for heat exchange.

The internal portion of the rotary tube cooler drums would be operated under an inert atmosphere to maintain product stability at the high inlet temperatures. The inert gas pressure would be maintained slightly above ambient to reduce the in leakage of air. Any excess inert gas from the coolers would be vented to the inlet of the Reactor gas recirculation fan.

Rotary tube coolers would be designed to accommodate an accelerated SynCoal® flow rate and obtain sufficient cooling for product stability. This would allow an accelerated system shutdown should a Dryer or Reactor upset require it.

Specifications for the coolers are provided in Appendix B-4.

2.5 Stabilization

Stabilization is a process by which the potential spontaneous combustion characteristic of the cooled SynCoal® is reduced. Stabilization involves the alternate heating and cooling if the SynCoal® to facilitate the stabilizing oxidation reaction.

Stabilization equipment is composed of a specialized variation of the Dryer or Reactor fluid bed. Its purpose is to oxidize and cool the SynCoal® in a controlled manner. The stabilization fluid bed reactor, as shown in the Process Flow Diagram 97-813-012, would be comprised of a dual fan, high and low temperature gas supply system. These fans provide fluidization and oxidation of SynCoal® within a baffled fluidized bed reactor, incorporating gas recirculation and particulate removal for exhaust gas. The system would be designed to process infeed SynCoal® maintaining a residence time of 45 minutes at a maximum reactor gas inlet oxygen concentration of 20.0% with an oxygen sorption rate of 1.5% by weight of SynCoal®.

The stabilization fluid bed reactor would be a baffled unit wherein SynCoal® is alternately heated and cooled to facilitate the stabilizing oxidation reaction. A stabilization cooling centrifugal fan will supply ambient air to the two cooling sections of the reactor. This will simultaneously fluidize and cool the SynCoal® to maintain near 0% product moisture and lower the exiting product temperature from 250°F to 150°F.

The heated gas and inert gas will be drawn into two heating sections of the reactor through the stabilization recirculation fan. The process heating gas will pass through the stabilization heat exchanger to raise the recirculation gas temperature to 300°F prior to entering the stabilization fluid bed reactor.

SynCoal® will enter and exit the stabilization fluid bed reactor through double dump valves. Residence time will be controlled on the basis of gas differential pressure which will actuate the bottom mounted double dump valve, discharging a uniform material volume per actuated cycle directly to the rehydration belt conveyor.

Stabilization is not included in the M. R. Young Power Station version of the SynCoal® Reference Plant Design. A discussion of the basis for this decision is provided in Section 4.5.

2.6 Rehydration

Rehydration is the process by which water is added to the SynCoal® to provide additional stabilization and dust suppression. Rehydration consists of controlled quenching with water addition that would provide additional cooling and a heat sink for so that additional oxidation can occur but at a reduced rate. The rehydration system, as shown in the Process Flow Diagram 97-813-012, would be comprised of an enclosed belt conveyor receiving 150°F oxidized SynCoal® from the stabilization fluid bed reactor, whereon water will be added for additional stabilization and dust suppression.

The stabilization fluid bed reactor would discharge oxidized SynCoal® through a double dump valve through a material spreader directly to the enclosed rehydration belt conveyor. The spreader will limit conveyor SynCoal® bed depth to 12" at the maximum throughput. The conveyor will be equipped with water spray stations mounted to the conveyor enclosure comprised of quick-release coupled hoses connected to pipes with nozzles providing a fan shaped spray to fully cover the width of the belt. Water flow will be adjusted manually with flowrate determined by nozzle pressure. The rehydration conveyor will be sized to provide sufficient residence time and water to rehydrate the SynCoal® to a maximum of 8% moisture by weight and lower the bulk temperature to 100°F.

Rehydration is not included in the M. R. Young Power Station version of the SynCoal® Reference Plant Design. A discussion of the basis for this decision is provided in Section 4.5.

2.7 Cleaning

Cleaning is the process by which a portion of the ash and sulfur containing fractions are removed from SynCoal®. A cleaning system, as shown in the Process Flow Diagram 97-813-012, would be comprised of a cleaning screen, coarse and fine fraction stoners and a coarse fraction separator (gravity table). The cleaning system would provide separation of high specific gravity waste fractions substantially comprised of pyrites and rocks from the product streams.

The SynCoal® for Reference Plant Design, would discharge to a single deck cleaning screen a from either the Reactor, Stabilizer, or Rehydrator. Material size separation would be effected on the vibrating screen deck, segregating the discharge product streams into a coarse and fine fraction. The differentiation between coarse and fine fraction at Colstrip has been shown to be approximately 10 mesh, but would need to be based upon actual feedstock testing.

The coarse fraction from the screen would discharge to a coarse fraction stoner wherein separation of higher specific gravity fractions from product would be effected through vibration and fluidization. During separation, the high specific gravity solids remain in contact with the inclined deck, migrating up toward the waste discharge. The lighter product fractions would be partially fluidized and move down the deck toward the product discharge. The high specific gravity solids discharged from the coarse fraction stoner would be introduced to the coarse fraction separator. The gravity table would operate on a principle similar to the stoner, but provides greater cleaning and separation efficiency. Moveable side-mounted baffles would allow for manual adjustment of waste/product fraction separation, discharging both flows from the same side of the unit.

The fine fraction from the screen would discharge to a new fine fraction stoner wherein separation of higher specific gravity fractions from product would be effected in a similar manner to that of the coarse fraction stoner. The product SynCoal® fractions from the coarse fraction stoner and gravity table and the fine fraction stoner would discharge into product storage or load-out facilities.

The Cleaning step was not included in the M. R. Young Power Station version of the SynCoal® Reference Plant Design. Section 4.6 provides a discussion of this decision.

2.8 SynCoal® Feed System

The design of a storage and/or feed system for the SynCoal® P produced by a Reference Plant would be dependent upon the needs of the individual plant. As an example, the product storage and boiler feed system for the M. R. Young Power Station version of the Reference Plant Design is shown schematically on P&ID 97-813-045 through 97-813-047. The basis of equipment selection is provided in Section 4.7. As indicated, once the SynCoal® is discharged from the cooler, it would be sized to meet the needs of the M. R. Young Power Station cyclone burners and transported to the product storage bins by conveyors. Each boiler will have an individual storage bin for SynCoal®. The amount of SynCoal® added to each storage bin will be monitored so that consumption by each boiler can be determined. These storage bins will be located near the SynCoal® facility.

From the individual storage bins, SynCoal® will be transported through a pneumatic transport system to individual surge bins for each cyclone burner. These surge bins will be located near the cyclone burners within the boiler structures. A rotary feed system will meter the SynCoal® into a gravity feed line that will intersect each cyclone burner lift line. The amount of SynCoal® fed to each burner will be adjusted by the boiler operator by controlling the speed of the rotary airlock.

In the event of a boiler trip, the main fuel trip (MFT) valves located at the end of each lift tube delivery pipe would activate and stop flow to the cyclone burner.

All open materials handling equipment, would be equipped with dust collection hoods routed through a tapered duct ventilation system to the SynCoal® baghouse. Material collected by this baghouse would be introduced back into the SynCoal® product system as it enters the storage bins. Gases used for pneumatic transport would also be filtered prior to discharge.

Specifications for a SynCoal® transfer and feed system are provided in Appendix B-5.

2.9 Process Vent Gas Handling

The SynCoal® process exhaust gases would carry primarily water vapor, a light loading of fine particulate material and VOCs. For the Reference Plant Design, analyses have shown this stream would be beneficial to either M. R. Young unit efficiency if it were vented into the radiant section of the boiler. The increased mass flow would decrease the flue gas temperature and increase heat transfer in the convection sections of the boiler.

The combined Dryer, Reactor, and Cooler vent gases would be routed to a common "vent gas" header at the SynCoal® processing plant. The composition of the gas is expected to be 95%H_2O, 4% N_2, 0.1% CO, 0.5%O_2, 0.1% hydrocarbons, and 100 ppm of H_2S and other combustibles. The vent gas temperature at the boilers is expected to be approximately 251°F. All of the vent gas would be routed to the Unit 2 gas recirculation fan inlet and injected into the boiler radiant section.

In the event of a boiler trip, the trip signal would activate MFT valves located at the boilers to shut off the process vent gas. An additional valve would close at the SynCoal® processing plant to shut the process vent gas supply to the vent gas header while diverting the process vent gas. A process upset of this type would immediately shut off steam flow to the process heat exchangers as well as the lignite supply. It is envisioned that the off-gassing of the process would continue through the emergency vent to atmosphere for approximately 20 minutes per event. Treatment of this gas prior to release to the atmosphere would be as per local environmental requirements.

2.10 Utilities

Utilities to be provided for the SynCoal® Reference Plant include power, process water, potable water, stack gas, inert gas and fire suppression water. A brief description of each utility including estimated service requirements is provided below.

2.10.1 Power

Estimated process power requirements are shown in Table 2. The majority of power would be consumed by the lignite feed system, Dryer fan, Reactor fan, Cooler system, baghouse fans, and the SynCoal® feed system. Other motor driven equipment including motorized valves, pumps, cooling tower and miscellaneous smaller equipment would account for the remainder of the power consumption. These are presented as a single horsepower requirement.

It is assumed the power would be supplied by a 69 kV source available on site. Connection to this source would require towers and conductors which are within the scope of the Reference Plant design.

The substation would consist of a power transformer with a single bus connection. The primary windings of the transformer will be protected with fuses and surge arresters. High voltage disconnects that are ganged and allow operation from ground level will be installed to provide isolation for the substation high voltage equipment. The secondary windings of the transformer will be resistance grounded using a resistor suitable for dusty outdoor installation. Two unit substations

TABLE 2
Process Power Requirements
100 tph SynCoal® Reference Plant Design

Usage	Hp	Hz	Ph	Voltage
Lignite Feed System	300	60	3	480
Dryer Fan	3,000	60	3	4,160
Reactor Fan	3,000	60	3	4,160
Cooler System	300	60	3	480
SynCoal® Feed System	1,400	60	3	480
Baghouse Fans	600	60	3	480
Miscellaneous	2,700	60	3	480
Total:	**11,000 Hp**			

would be configured to supply 480 VAC equipment and four 480 V, 800 A, Motor Control Centers (MCCs) would be supplied by the unit substations (two on each substation). Each MCC would have six sections, with each MCC capable of containing 60 motor starters.

Control

The plant control system would consist of a Programmable Logic Controller (PLC), a graphical operator interface, and an uninterruptible power supply. The PLC would monitor and control approximately 400 digital inputs, 150 analog inputs, 75 digital outputs, and 60 analog outputs. The graphical interface package would be a PC based system that would allow monitoring and control plant functions. The uninterruptible power supply would consist of a battery powered inverter and transformer with a gasoline engine powered DC generator to provide conditioned power in the event of an extended power outage. This PLC would be integrated into the existing PLC network.

2.10.2 Process Water

Process water would be required for supply to spray nozzles in the processing equipment to produce a false load for the heat exchangers prior to introduction of lignite to the process. It is anticipated that approximately 145 gpm of water will be required during startup by the Reference Plant. This water will be suppled by the existing M. R. Young facility water system to a surge tank within the SynCoal® facility. Dedicated pumps would then provide the SynCoal® processing equipment with water as needed.

Cooling water would be required for supply to the product rotating drum coolers. Cooling water pumps would be required to circulate approximately 1,000 gpm to the product coolers through piping routed from a new cooling tower. The cooling tower would be designed to transfer approximately 25 mmBTU/hr, with makeup water supplied from the SynCoal® facility water surge tank. Chemical treatment of cooling tower water would be provided, including pH adjustment and biocide and anti-scalant addition.

2.10.3 Potable Water

Potable water would be required to supply a rest room to be located at the control room. It is estimated that 2 gpm would be required for this need.

2.10.4 Compressed Air

Compressed air would be required for controls, diverter, double-dump and slide gate valves; dampers; and baghouse pulse cleaning. Compressed air would be provided by a new compressed air system comprised of a helical screw-type compressor and desiccant air dryer.

2.10.5 Inert Gas

A membrane type nitrogen separation system would be used to provide an inert gas supply for the SynCoal® facility. This nitrogen facility would be owned and operated by a third party which would assure a supply of nitrogen under a prearranged contract.

2.10.6 Fire Suppression Water

Six (6) fire suppression water zones/loops and a pump would be provided for in the Reference Plant Design, integrated into the existing M. R. Young fire suppression system.

2.11 Structures

Referencing drawings 97-813-070 through 97-813-072, the overall dimensions of the plant are approximately 200 feet long by 70 feet wide by 180 feet high. These drawings also show the approximate location of the processing equipment. The process would be supported on structural steel framing and housed in a single steel building. An enclosed maintenance area would be provided on the ground floor.

2.12 Plant Operations

It is expected that operating and maintenance staffs of the Reference Plant would be supplied by the power plant. Three operators would staff the plant full time on four shifts, and two additional maintenance staff would be available on day shift Monday through Friday. Plant supervision would be provided by the shift supervisors of Unit 2.

3.0 PERMITTING REQUIREMENTS

Since the SynCoal® Reference Plant exhibits the potential to emit particulate to the atmosphere and use and discharge water, the following sections present a summary of applicable environmental permitting requirements for a facility located in North Dakota. It is expected that permitting calculations and applications would be similar for most proposed locations of the Reference Plant Design.

3.1 Air Permitting Requirements

Potential air emissions from the SynCoal® facility would be in the form of particulate matter (PM) from materials handling operations and process vent gases during an emergency. Primary pollutants of the latter gases are sulfur compounds and carbon monoxide (CO). Control of these potential emissions is addressed in Section 2.0 of this report.

Referencing Section 4.5 of the April 1994 Impact Study in which Environmental Protection Agency (EPA) AP-42 methods were used to calculate emissions, particulate matter (PM) emissions from the 100 tph SynCoal® facility would likely not exceed the PM_{10} 15 tpy threshold for classification as a "significant emissions increase" per North Dakota Administrative Codes (NDAC) Chapter 33-15-15-01. Given this circumstance as well as the fact that lignite upgrading falls outside the definition of "coal drying" in Subpart Y of the new source performance standards (NSPS), the only NSPS standard that would apply to the new facility would be compliance with a 20% opacity standard.

Similarly, since PM_{10} emissions would not exceed 15 tpy, addition of the new facility to the MPC site which is defined as a major source, would not be classified as a "major modification." However, under NDAC Chapter 33-15-14-02, MPC would be required to apply for a permit to construct because the new facility would be a "modification to an existing source." As a part of the permit application, MPC would be required to submit calculations showing the anticipated emissions.

Changes in emission levels of SO_2, NO_x and CO would not be anticipated since all process vent gases containing Volatile Organic Compounds (VOCs) would be directed to the radiant section of the power generating units. Since these units are already permitted to fire the intended mass flow of lignite, no permit modifications would be anticipated.

In December of 1996, an application for a permit to construct was submitted to the North Dakota Department of Health. This permit was issued in January 1997.

3.2 Water Appropriation and Discharge Permitting Requirements

The total average demand for water would be approximately 50 gpm, as delineated in the following:

- Cooling water for the process would be anticipated to be supplied via an open style cooling tower rated at 860 gpm. Assuming 3.6% losses to evaporation and drift and 0.7% blowdown for maintenance of water quality, a total makeup water flow of 43 gpm to the cooling tower would be anticipated.

- The average flow for facility wash down and use during startup and restart operations would be anticipated to be 5 gpm.

- Approximately 2 gpm for sanitary usage.

The Missouri River via Nelson Lake would be used as a source for the 50 gpm water supply. Submittal of a water appropriation permit application would be required with an estimated 160 day agency processing period.

Wastewater flow from the facility would be anticipated to average 11 gpm, as delineated in the following:

- A time weighted average of approximately 2 gpm of wash down water would be collected and pumped to the existing MPC wastewater treatment system.

- Approximately 7 gpm of cooling tower blowdown.

- Approximately 2 gpm of sanitary waste water.

All process water would be processed by the existing wastewater treatment facility. Sanitary waste water would be processed by the existing sanitary wastewater treatment facility. Revision of the existing wastewater discharge permit would not be anticipated.

4.0 UNIT OPERATIONS EVALUATION

During initial stages of Reference Plant engineering, an analysis of unit operation alternatives was performed to optimize the balance of capital and operating costs and system availability. The following sections summarize the evaluations while Appendix C provides detailed documentation.

4.1 Process Heating Unit Operations Evaluation

Process heating can be supplied by a hot, low pressure gas or by high pressure steam. These process heating options are illustrated in Drawings 97-813-041 and 97-813-011. Drawing 97-813-011 indicates the hot gases coming from a furnace. However, it possible for the SynCoal® process to be integrated into a facility which already produces a source of hot gas which would eliminate the need for a furnace. High pressure steam would likely come from an industrial boiler or power station. Selection of the optimum heating system requires evaluation of the cost of the equipment associated with the heat exchange system as well as the cost of fuel on the final product.

Selection of the process heating system for the illustrated Reference Plant Design, involved comparison of low pressure direct-fired hot gas to high pressure indirect steam heat exchangers. A fired heater systems would consist of a gas to gas heat exchanger, fuel burner, control system, and auxiliary systems including fuel handling, stack gas treatment, blower and stack. It is anticipated that the most probable fuels for a hot gas system would be natural gas or the same feedstock used for the SynCoal® process. However, alternative fuels such as fuel oil, petroleum coke, and biomass could be used depending on availability and economy.

An advantage of a fired heater and exchanger system was the relatively common nature of the application which would allow a number of vendors to meet the specification. However, the fired heater systems currently in use at the ACCP have shown that direct firing has high maintenance costs due to the impact of recycled gas chemistry.

A steam heat exchanger system would involve in-duct style heat exchangers, receivers, and high pressure flow control valves. This eliminates the need for many of the auxiliary systems required for a furnace option but requires the utilization of high pressure heat exchangers.

The advantages of a steam heat exchange system, for the illustrated Reference Plant Design, is its ability to use excess power plant steam at a low purchase cost compared to combustion of fuel. The steam system was also equated with greater availability, lower maintenance costs and being a familiar process fluid at a power station. However, the requirement to supply and use steam at 2,400 psia would increase the difficulty of finding qualified vendors to supply the heat exchange equipment.

As indicated by Table 3, the direct cost associated with process heating option is fairly similar regardless of the type of heating method chosen. The indicated equipment costs are all within 5% which considering the accuracy of the estimate is not a significant variance. These costs however are based upon generalized assumptions and do need to be evaluated for any given application. Additionally, Table 3 does not consider the operating cost of process heating on the sale price of SynCoal®. Because these costs would be site dependent, each facility evaluation would require a separate analysis to determine the overall economics for the project.

In the case of the Reference Plant Design, natural gas heating was eliminated because there is no nearby source of natural gas and a natural gas pipeline would result in significant expense. A lignite fired heater had cautious support depending upon its impact upon area emissions. However, evaluation of the capabilities of the M. R. Young Power Station indicated that it did have sufficient steam capacity to provide adequate heat to the SynCoal® facility. Since this heat was available at minimal incremental cost, steam heating was chosen as the most economical method of process heating.

Table 3
Process Heating Direct Cost Comparison

	Heating Method		
	Lignite Fired	**Natural Gas Fired**	**Steam**
Furnace	$1,150,000	$900,000	$0
Fuel Supply System	$327,000	$100,000	$0
Ash Handling System	$69,000	$0	$0
Wet Scrubbing System	$1,377,000	$0	$0
Exhaust Stack	$149,000	$0	$0
Steam Piping*	$0	$0	$1,200,000
Natural Gas Service**	$0	$1,000,000	$0
Heating Supply System Total	$3,072,000	$2,000,000	$1,200,000
Dryer Heat Exchanger System	$0	$0	$807,000
Reactor Heat Exchanger System	$300,000	$300,000	$994,000
Total Other Equipment Costs	$22,469,000	$22,469,000	$22,469,000
TOTAL EQUIPMENT COST	$25,841,000	$24,769,000	$25,470,000

* Cost of steam piping is dependent upon the relative location of steam source and steam properties

** Cost of natural gas service is dependent upon the relative location of nearest natural gas supply

4.2 Dryer Unit Operations Evaluation

Two levels of unit operations evaluation were performed in arriving at a technology selection for drying. Initially, direct contact drying using hot gas in a fluidized bed (either vibratory or static) was compared with indirect drying in mechanically agitated, oil heated systems.

Referencing Section 4.3, in arriving at a candidate fluidized bed technology, the static bed style was selected over the vibratory style based on the inability to scale-up vibratory units and unsatisfactory maintenance experience at the ACCP.

During comparison of static fluid bed technology with indirect, mechanically agitated systems, cost and applications data for the former systems was obtained through extrapolation from prior studies to which Carrier and Heyl & Patterson (suppliers of static bed plate fluid bed units) provided cost data. Cost and availability data for indirect drying systems was obtained from Heyl & Patterson, Holo-Flite and Hosakawa Bepex.

Fluidized bed systems exhibited higher capital costs due to the cost of a high pressure gas to gas heat exchanger, gas and fines handling systems and additional structural support elements. A substantially higher operating cost for the fluidized bed systems was attributed largely to fan horsepower. From an availability standpoint, the indirect dryers were rated lower than static fluidized beds though the redundant capability of indirect drying units addressed this inequity.

Based on the foregoing, a more detailed evaluation of the three indirect drying systems was undertaken. Referencing Appendix C-1, a quantitative matrix evaluation of indirect drying systems was prepared based on particular areas of concern including general arrangement compatibility, similar operation experience, simplicity and robustness of construction and commercial terms. Evaluation weighting was established on a zero to ten scale, with zero being unacceptable and ten being superlative. Actual weighting values were selected through design group discussion of all aspects of each tender, with the goal of establishing an objective basis.

Inquiry documents were issued for vendor proposal and included a performance specification based on data from a preliminary M&EB. No equipment configuration was specified; it was the intention of the performance bidding to allow each manufacturer to apply their expertise in design of heat transfer equipment for the application.

Upon selection of a preferred vendor of indirect drying technology, additional pilot testing was performed. It was found that actual heat transfer coefficients for the lignite sizing to be used were much less than had been originally predicted. This would result in a two to three-fold increase in the number of indirect drying units. This made indirect drying economically unattractive relative to fluidized bed drying. Therefore, fluidized bed drying was selected for the Dryer. These test results are in Appendix D-2.

4.3 Reactor Unit Operations Evaluation

Selection of the Reactor unit operation was driven largely by Section 29 Letter Ruling requirement for direct contact processing at temperatures exceeding 750°F and exit lignite temperatures of 450°F to qualify for alternative fuel status. These requirements when combined with the nature of the SynCoal® process necessitate comparison of static bed, traveling bed and fluidized bed reactors.

In previous studies conducted by Rosebud SynCoal® Partnership engineers, direct contact static bed reactors operating in batch mode were considered and eliminated due to insufficient gas to solids ratios and discontinuity of heat distribution typically exhibited by the systems. Likewise, direct contact traveling bed reactors in the form of horizontal and vertical calciners were eliminated for the same reason.

Comparison of static bed plate fluidized bed with vibratory fluidized bed technologies took into consideration the four years of operating experience with six of the latter style reactors at the ACCP. It was found that within approximately 500 hours of operation, the ACCP vibratory fluidized bed units exhibited significant metal fatigue cracking and high maintenance costs for replacement of moving parts. Neither of these issues has yet to be fully resolved. Based on the ACCP experience, the vibratory fluidized bed units may have a relatively short service life and/or higher maintenance costs than a static fluidized bed. In addition, the existing vibratory fluidized bed units in use as the ACCP are the largest units in existence. Increasing the capacity of a plant using vibratory fluidized bed units can only be obtained by increasing the number of units.

Therefore in consideration of the foregoing, static bedplate fluidized bed technology was selected for the Reactor.

4.4 Product Cooling Unit Operations Evaluation

Selection of the product cooling unit operation initially involved comparison of direct contact with indirect contact cooling technologies for quenching product temperatures from 450°F to 150°F. Since the Reactor would be a static bedplate fluidized bed, direct contact cooling with gases in a final partitioned section of the unit was considered. Investigations into this alternative proved this to be an uncommon design and therefore insufficient operating data was available on which to base a reliable design.

Direct quench cooling with water was also investigated and eliminated as a viable alternative based on the potential for moisture reabsorption and as discussed in section 4.1, the high horsepower requirements and resulting operating costs.

Evaluations of indirect cooling involved comparison of mechanically agitated, water-cooled technologies over direct quench. Four years of experience with a vibratory fluidized bed at the ACCP has confirmed that direct contact plug flow coolers require significantly more horsepower when compared to indirect contact coolers.

Comparison of mechanically agitated systems involved review of application data for the following systems:

- Rotary tube coolers
- Rotary screw and disc coolers

The two system types have similar capital costs though it was determined that rotary tube coolers held an advantage based on their relative simplicity and scale-up potential.

Appendix C-2 contains results of this evaluation.

4.5 Product Stabilization and Rehydration Unit Operations

These process steps were not included in the M. R. Young illustration of the Reference Plant Design because the need for long term storage in an oxidizing atmosphere was not anticipated as part of the initial goals of the project. However, it was anticipated that these processing steps would be added at a later date to support market development for off-site regional sales.

4.6 Product Cleaning Unit Operations Evaluation

The requirement for cleaning is based upon economics of feed stock costs versus the value of the resulting lower sulfur and ash SynCoal® product. The cleaning equipment components for a Reference Plant Design are identical to the equipment at the ACCP demonstration facility in Colstrip, Montana. No further work on specifying this equipment or process optimization has been accomplished because this type of equipment is only required where a high pyrite content feed stock is encountered and a lower sulfur product is desired. Justification for purchase and operation of this equipment can only be made when a premium price can be gained on the resultant fuel that has been cleaned. Rosebud SynCoal® Partnership has not found a premium value in the marketplace for a cleaned SynCoal® product. Therefore, a cleaning operation was excluded from the M. R. Young version of the Reference Plant Design. However, it can be added to the process at a later date and may be warranted, if environmental regulations necessitate burning lower sulfur fuels.

4.7 Product Feed & Storage Unit Operations Evaluation

SynCoal® discharged from the rotary tube coolers at a combined flow of 65 tph would be transferred to storage bins maintained under inert gas conditions. Oxygen must be reasonably excluded in view of the tendency for non-stabilized SynCoal® to spontaneously combust when stored for greater than 24 hours when the product temperature is greater than 150° F.

During initial stages of product feed system design, the use of belt or other means of mechanical conveyance was investigated. However, based on the dusty nature of the fuel and the potential for combustion, mechanical conveyance systems were eliminated.

Over a period of two years, pneumatic conveyance systems had been used with moderate success for experimental feeding of SynCoal® to M. R. Young Unit 1. The system was composed of seven dilute phase feeders with dedicated blowers, all of which received SynCoal® from a common bin. The fuel was transported to each lift line at rates varying from 0 to 5 tph. Operational problems experienced were primarily associated with mechanical operation reliability, consistent SynCoal® feeding from the bin and ability to feed into a lift line operating at 12 psig. In large part, these problems were attributable to inadequate equipment capacity, bin design and the lack of robust equipment design.

Based on the foregoing, pneumatic conveyance systems were selected for the Reference Plant Design with the provision that the mechanical equipment and material flow problems exhibited by the experimental system be mitigated.

5.0 VENDOR SELECTION

On completion of the technology evaluation for each process step, vendors were selected to advance engineering. The following sections summarize the vendor selection process while Appendix C provides copies of working documents.

5.1 Dryer Selection

The evaluation of drying technologies presented in Section 4.2 resulted in the selection of a fluidized bed as the preferred technology. Following the decision to use a static bed plate fluidized bed unit for the Dryer, the decision to select Carrier Company as the process vendor was made based on the relatively high amount of prior similar experience and extensive working relationship.

5.2 Reactor Selection

Following the decision presented in Section 4.3 to use a static bed plate fluidized bed reactor for the 2nd stage, the decision to select Carrier Company as the process vendor was made based on the high amount of prior similar experience and extensive working relationship.

5.3 Cooler Selection

The comparison presented in Section 4.4 resulted in selection of FMC's Roto-Fin cooler based on installed simplicity, quality of system design and construction, capital cost and depth of experience in similar applications. The Heyl & Patterson rotary tube cooler provided similar features though capital cost was higher and experience in similar applications was lacking.

Appendix C-2 provides detailed data regarding vendor selection.

5.4 Heat Exchanger Selection

The comparison presented in Section 4.1 resulted in selection of steam heating based on economic, operational, and environmental factors. Initial process conceptualization resulted in the selection of a tube and shell heat exchange system because of its simplicity. Initial specifications were submitted to vendors of this type equipment. Key heat exchanger requirements specified to vendors included:

- Desired low pressure drop to minimize gas circulating fan horsepower.
- Desired maximum heat transfer coefficients and adherence to Tubular Equipment Manufacturers Association (TEMA) standards.
- 2,400 psig differential pressure

Proposals were solicited from:

- Tampella Power
- ABB Lummus
- EFCO
- Yuba Heat Transfer
- Yula

Based upon the responses received and in-office interviews, Yuba was selected as the preferred vendor of a tube and shell type heat exchanger system. Appendix C-3 provides detailed data regarding this decision.

However, as engineering progressed, predicted particulate loadings it the fluidization gas indicated that significant particulate deposition could occur in the heat exchangers. Also, in order to fabricate a tube and shell heat exchanger that would accommodate high pressure steam on one side and low pressure process gas on the other, the high pressure medium must be on the tube side of the exchanger. This would place any particulate deposition on the shell side, which would be difficult to remove.

This prompted a change to a system utilizing in-duct type heat exchangers which is the system presented in drawing 97-813-041. This type of system is more complex but the equipment is more common. Proposals for these type heat exchangers were solicited from:

- Yuba Heat Transfer
- Eco, Inc.
- Applied Thermal Systems, Inc.
- Rome-Turney Radiator Company
- Aerofin Corporation.

Based upon the responses received Eco was selected as the preferred vendor of the in-duct type heat exchangers. Appendix C-3 provides detailed data regarding this decision.

5.5 Product Feed System Selection

The scope of work specified to system vendors is included as an equipment specification in Appendix B-5. Proposals were solicited from:

- Smoot
- Delta-Ducon
- Fuller-Kovako
- Air Cure

Smoot Corporation was selected based on their system design, construction quality, experience in similar applications, and cost.

Appendix C-4 provides detailed data regarding vendor selection.

6.0 APPLICABLE OPERATION TESTING

As with any emerging technology, a variety of testing is required whenever the feedstock is altered or the process is re-sized. For the Reference Plant Design, the following tests were completed:

- Lignite testing in the ACCP demonstration facility
- Holo-Flite suitability
- Carrier fluid bed suitability
- SynCoal® supplemental boiler fuel suitability

The results of test work were used to develop an acceptable design and to provide the basis for an economic evaluation of the installation.

6.1 Lignite Testing at ACCP

To confirm that the lignite was upgradeable using the SynCoal® technology, two full demonstration scale tests on BNI lignite and one test on Knife River lignite were performed. These tests confirmed that lignite is upgradeable using the SynCoal® technology and that a calorific upgrade of over 50% can be achieved. Data from the final test on BNI lignite in September 1993 is included in Appendix D-1 of this report.

6.2 Holo-Flite Suitability Testing

As indicated in Section 4.2, initial investigations indicated that a Holo-Flite screw dryer appeared to be the most suitable device for drying the lignite. However, since no facilities were currently utilizing this equipment to dry lignite of the required size range, Svedala Holo-Flite was engaged to perform laboratory and bench testing.

In January of 1996, 25 barrels of sized lignite from the M. R. Young Power Plant (BNI mine) was sent from Center, North Dakota to the Holo-Flite testing facility in Colorado Springs, Colorado for testing. Testing consisted of a group of preliminary heat transfer coefficient determination tests using a 4" diameter dual screw Holo-Flite test unit with Dow-Therminol 66 as the heat transfer media pumped through the unit at 600°F. These tests were followed by confirmation tests using a 7" diameter dual screw Holo-Flite unit with Dow-Therminol 66 as the heat transfer media at 625°F.

The preliminary tests showed that the 3/4" minus lignite would only heat up to 201°F until approximately 50% of the moisture had been removed. A heat transfer coefficient of 9 BTU/ft^2-°F was derived from three tests in which 38% moisture lignite was dried to 18% moisture content in a series of three steps at 201°F.

The confirmation tests produced an overall heat transfer coefficient of 7 to 9 BTU/ft^2-°F from two tests in which 38% moisture lignite was dried to 15% moisture content and raised in temperature to 250°F. An additional confirmation test was completed in which 18% moisture content lignite (partially dried) was dried completely to 0% moisture content and raised in temperature to 340°F. The test data for this vendor test is included in Appendix D-2.

While this testing did demonstrate that the lignite could be dried with this equipment, the unexpectedly low heat transfer coefficients indicated that a large number of the units would be required to dry lignite at the desired rates. This made the cost impact on the overall project greater for the Holo-Flite screw technology than the fluid bed technology.

6.3 Carrier Fluid Bed Testing

In March of 1994, drying tests were performed on BNI lignite at the Carrier Vibrating Equipment Company test facility in Louisville, Kentucky. Superheated steam at atmospheric pressure was circulated through a 1 ft by 4 ft fluid bed reactor prior to feeding in the 38% moisture lignite. Two (2) groups of tests were performed, one for the Dryer stage, and one for the Reactor stage of the SynCoal® process.

The first tests were run using 600°F superheated steam and 36% moisture content lignite resulting in a partially dried lignite exiting the unit at 250°F with a moisture content of 15%. These tests confirmed the required gas velocity and horsepower for Dryer specification.

The second set of tests were run with 700°F superheated steam and 18% moisture content lignite. This resulted in a 400°F exit material at 5% moisture content for the first test. The second test resulted in a 450°F material exiting at 2% moisture content and the third test, a 500°F material at 0.5% to 1% moisture content. These tests confirmed the horsepower requirement for the full scale unit, the process temperatures and velocity of the exit gas from the unit. Also, fines production was measured during the test which confirmed the design basis amount.

The foregoing tests also indicated an optimal fluid bed deck design of 15° off horizontal.

On October 17, 1996, additional testing was performed at Carrier's facility to obtain estimates of bed loss percentages and the size of the particulate lost from the bed. This information was needed to properly design the Dryer and Reactor gas handling systems. It also would provide information concerning the expected dust loading in the two fluidization gas streams so that heat exchanger options could be evaluated and heat exchanger design specifications could be prepared.

Data from this testing is provided in Appendix D-3.

This testing indicated that with Carrier's expanded hood design, all of the particulate in the fluid bed smaller than approximately 0.012 inches (50 mesh) would be elutriated from the lignite into the gas stream. When this information was provided to the cyclone manufacturer, it was estimated that 85 to 90% of the elutriated material would be captured by the cyclones. However, since this system recycles most of the fluidizing gas, there is a particulate buildup in the gas stream. It was calculated that at steady state, the particulate loading in the Dryer and Reactor fluidization gas steams would be approximately 2.4 to 7.2 and 1.6 to 4.8 grains per actual cubic foot, respectively.

6.4 SynCoal® as Supplemental Boiler Fuel Testing

In order to quantify the benefits associated with burning SynCoal® in the M. R. Young Station boilers, it was necessary to perform testing. The object of this testing was to demonstrate that SynCoal® could be utilized in place of fuel oil in the cyclone burners and the quantity of SynCoal®, relative to fuel oil, that was required to produce the desired effect.

Currently, the M. R. Young Station utilizes approximately 3,000,000 gallons per year of fuel oil for deslagging operations. Data from these tests, provided in Appendix D-4, indicates, SynCoal® was successfully used as a replacement for fuel oil. Data from these tests indicated that approximately 20,000 to 30,000 tons of SynCoal® would be required to replace the fuel oil needed for deslagging operations.

This testing also indicated that the maximum amount of SynCoal® that could be utilized by a boiler would be dependent upon the design of the boiler. For units such as those at the M. R. Young Station, SynCoal® could be used for up to approximately 30% of the annual fuel requirement. Below 30% utilization, steam generation capacity increased. This allowed the recovery of some of the net steam production capacity that had been used for process heating in the SynCoal® process.

This data also implies that SynCoal® could supply 100% of the fuel for a boiler designed to utilize SynCoal® as the primary fuel.

7.0 CAPITAL COST ESTIMATES

A capital cost estimate for the Reference Plant Design was developed using vendor quotations for major process equipment and engineering factors for other direct costs. Table 4 presents a summary of the overall cost estimate contained in Appendix E. A description of the rationale used in preparing the cost estimate is presented below. As was previously indicated by Table 3 in Section 4.1, the equipment cost for process heating is similar regardless of method. Therefore, the design cost developed for the M. R. Young station should would be similar for any process heating option. It should also be noted that this cost estimate was developed for a specific site and should only be used as a guideline for the cost of facilities at other locations.

Table 4

Reference Plant Design Cost Estimate Summary

Division	Description	Cost
1	Engineering and Permits	$875,000
2	Sitework	$286,300
3	Concrete	$738,400
4	Masonry	$155,700
6	Metals	$1,722,300
7	Moisture/Thermal Protection	$721,300
8	Doors and Windows	$9,100
11	Process Equipment	$12,584,600
15	Mechanical Work	$5,419,700
16	Electrical Work	$2,957,650
	Direct Cost	$25,470,050
	Indirect Cost	$6,867,600
	Contingency	$2,263,636
	Profit	$1,730,064
	Startup*	$623,721
	Project Owners Cost*	$2,128,101
	Total Project	$38,459,451

* Dependant upon location and project specifics

7.1.1 Equipment Procurement Approach

Process equipment procurement was assumed to be conducted with the early approval of major equipment. Upon Owner approval of specifications, the Engineer would conduct bidding, collate bids and present a bid award recommendations. The sections required for early approval would be:

- Lignite Feed System
- Dryer
- Reactor
- Coolers
- Heat Exchangers
- SynCoal® Feed System

7.1.2 Construction Approach

Western SynCoal® would act as the project general contractor. Construction work would be performed on a time and materials basis by a full service local contractor providing construction services.

7.1.3 Engineering Approach

Engineering would be provided by a consulting engineering firm. Engineering review would be provided by Western SynCoal's engineer.

7.1.4 Pricing Basis

The pricing was based on vendor quotations for major equipment items, approximate material requirements based upon location and size of the facility, and historical construction estimating factors from local contractors.

Escalation

All prices were based on 1997 United States dollars. No escalation was included for the construction estimate since estimate was prepared as an accelerated installation type project.

Indirects

Indirect costs, as shown in Appendix E, are based upon contractor estimates and experience at the ACCP facility.

Contingency

A contingency of 7% was applied to the total of project direct and indirect costs.

7.2 Operating Costs

The cash operating costs are dependent upon the specific project location, local government policies and the business arrangements with the site host and customers. The following is intended to give some guidance to estimate the approximate costs for a plant operating in a normal fully scheduled mode. The cost are best categorized as variable with production and fixed on an annual basis.

Variable Cost (per ton of product)

Material Yield = Product Tons/Feed Tons

Feedstock = Price per ton /Material Yield

% Moisture Removed = (Moisture in Feed - Moisture in Product)/Moisture in Feed

Fuel = Price per MMBtu * 2.2 * Moisture Removed / Heat Transfer Efficiency

Electricity = Price per kWh * 36 / Material Yield

Water = price per 1000 gallons * 0.25

Fixed Costs (per year)

Labor = Ave. Annual Wage * Number of Operators

Admin. = Labor cost * 0.17

Maintenance = Initial Capital * 0.06

Supplies = Maintenance * 0.15

Insurance = Asset Value * 0.01

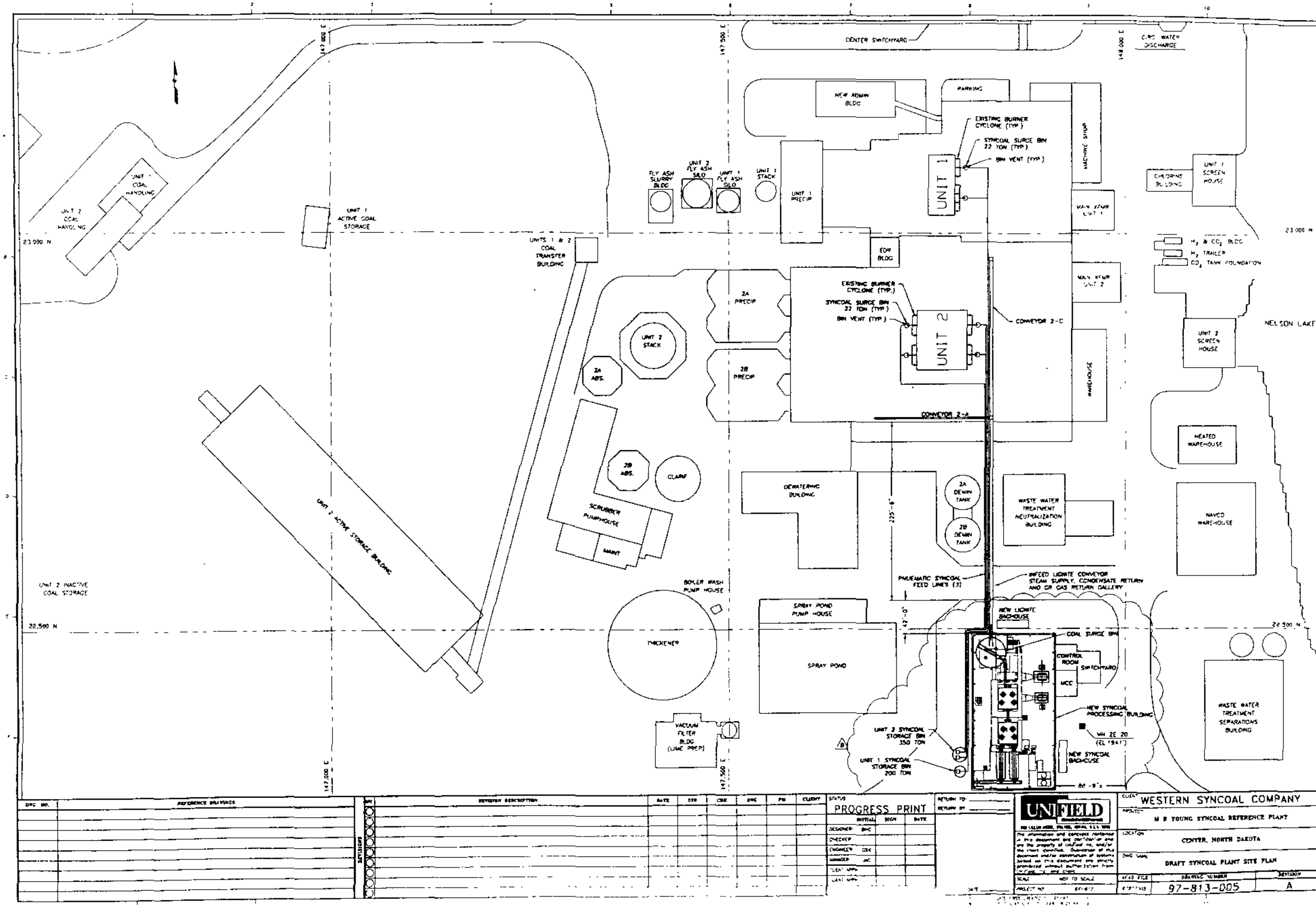
Prop. Taxes = Asset Value * 0.01

These cost are for example purposes only and may vary widely with location. They do not include local income or ad valorem taxes or special costs.

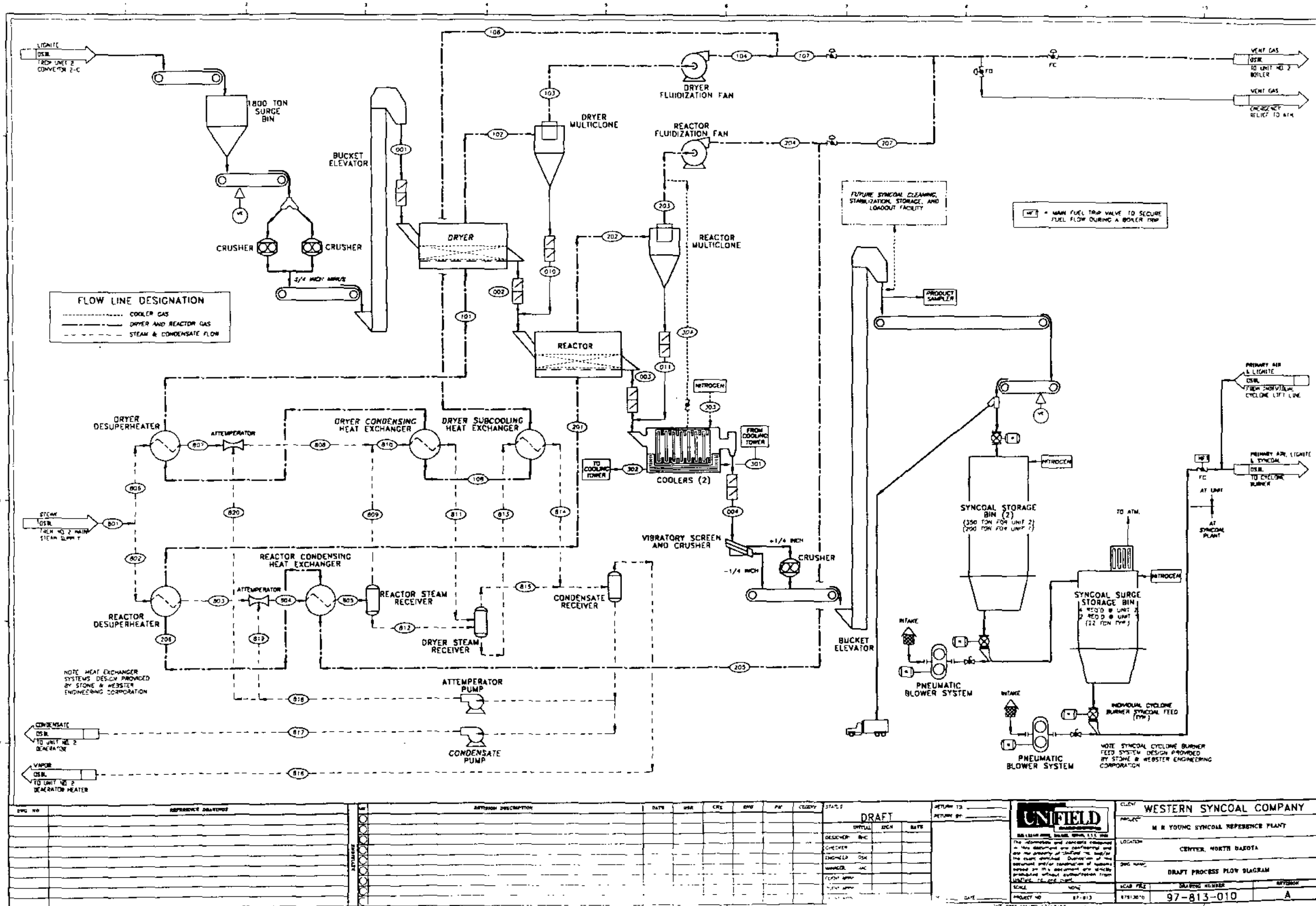
APPENDIX A

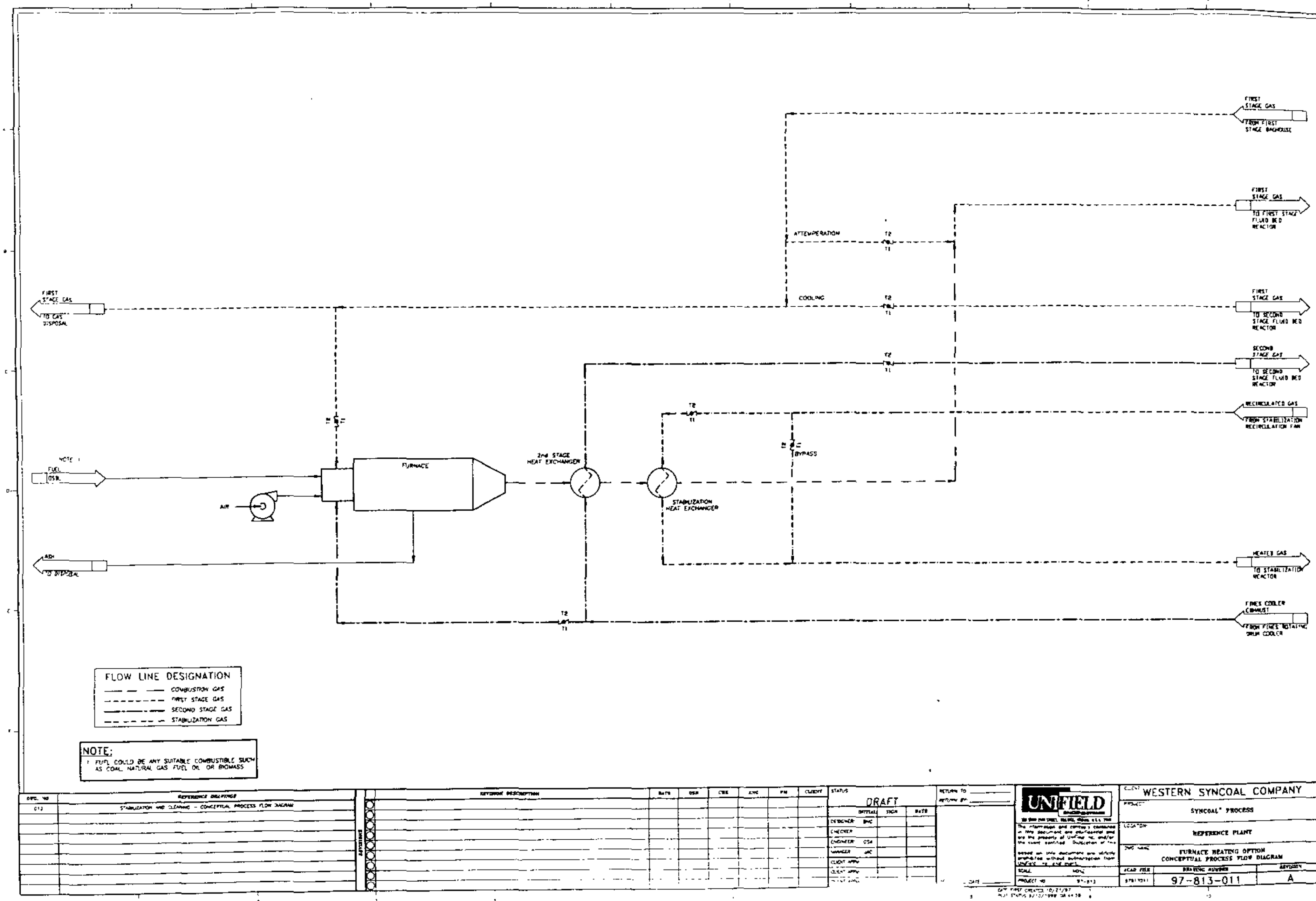
ENGINEERING DRAWINGS

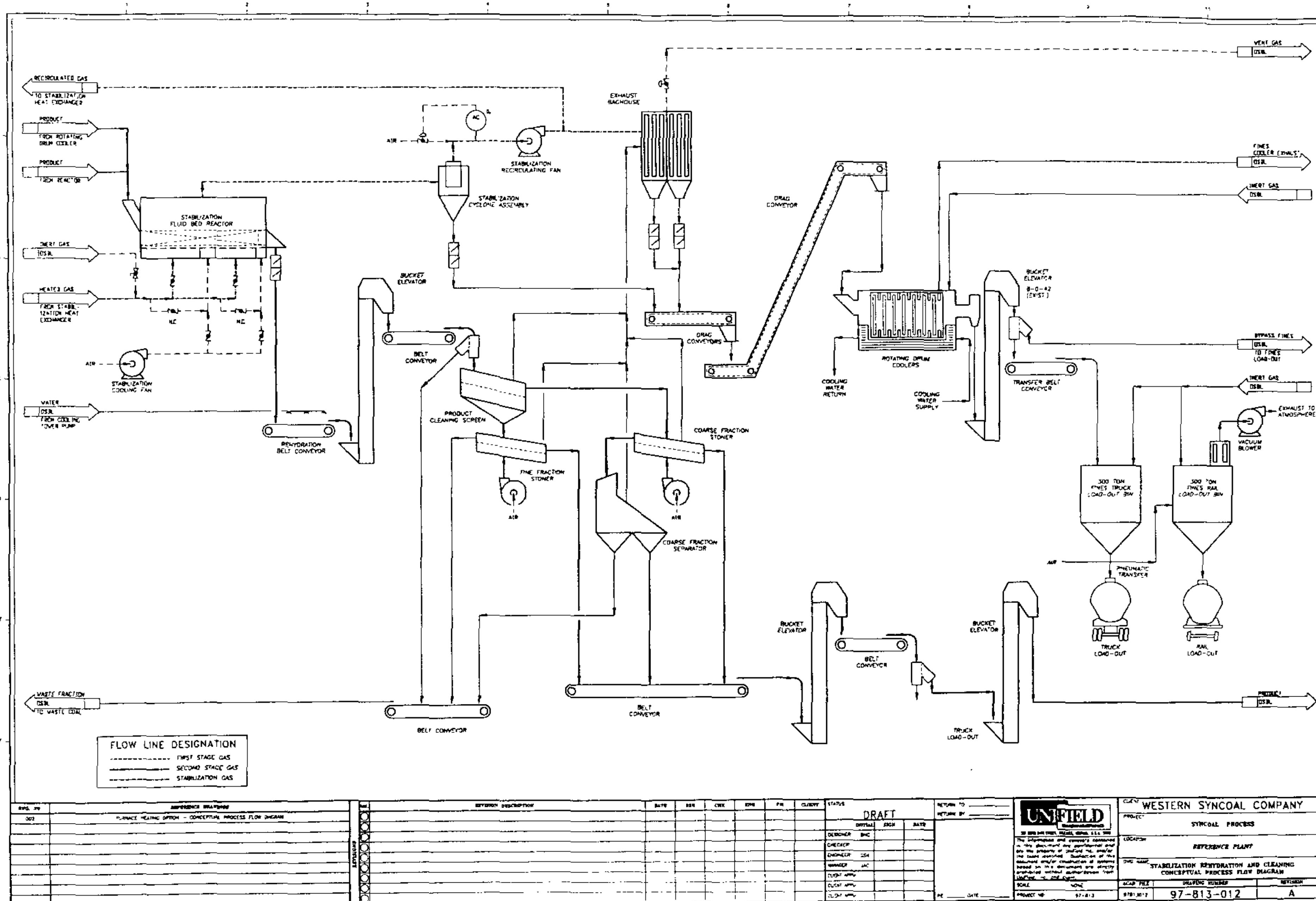
Site Drawings	
97-813-005	Site Plan
Process Flow Diagrams	
97-813-010	Reference Plant PFD
97-813-011	Furnace Heating Option PFD
97-813-012	Stabilization and Cleaning PFD
Piping and Instrument Drawings	
97-813-040	Lignite Infeed P&ID
97-813-041	Heat Exchanger System P&ID
97-813-042	Dryer P&ID
97-813-043	Reactor P&ID
97-813-044	Cooler P&ID
97-813-045	Material Transfer P&ID
97-813-046	SynCoal® Storage System P&ID
97-813-047	SynCoal® Feed System P&ID
97-813-048	Utility Systems P&ID
General Arrangement Drawings	
97-813-070	East Elevation
97-813-071	North Elevation
97-813-072	0' Floor Plan
97-813-073	12' Floor Plan
97-813-074	24' Floor Plan
97-813-075	34' Floor Plan
97-813-076	62' Floor Plan
97-813-077	104' Floor Plan
97-813-078	143' Floor Plan

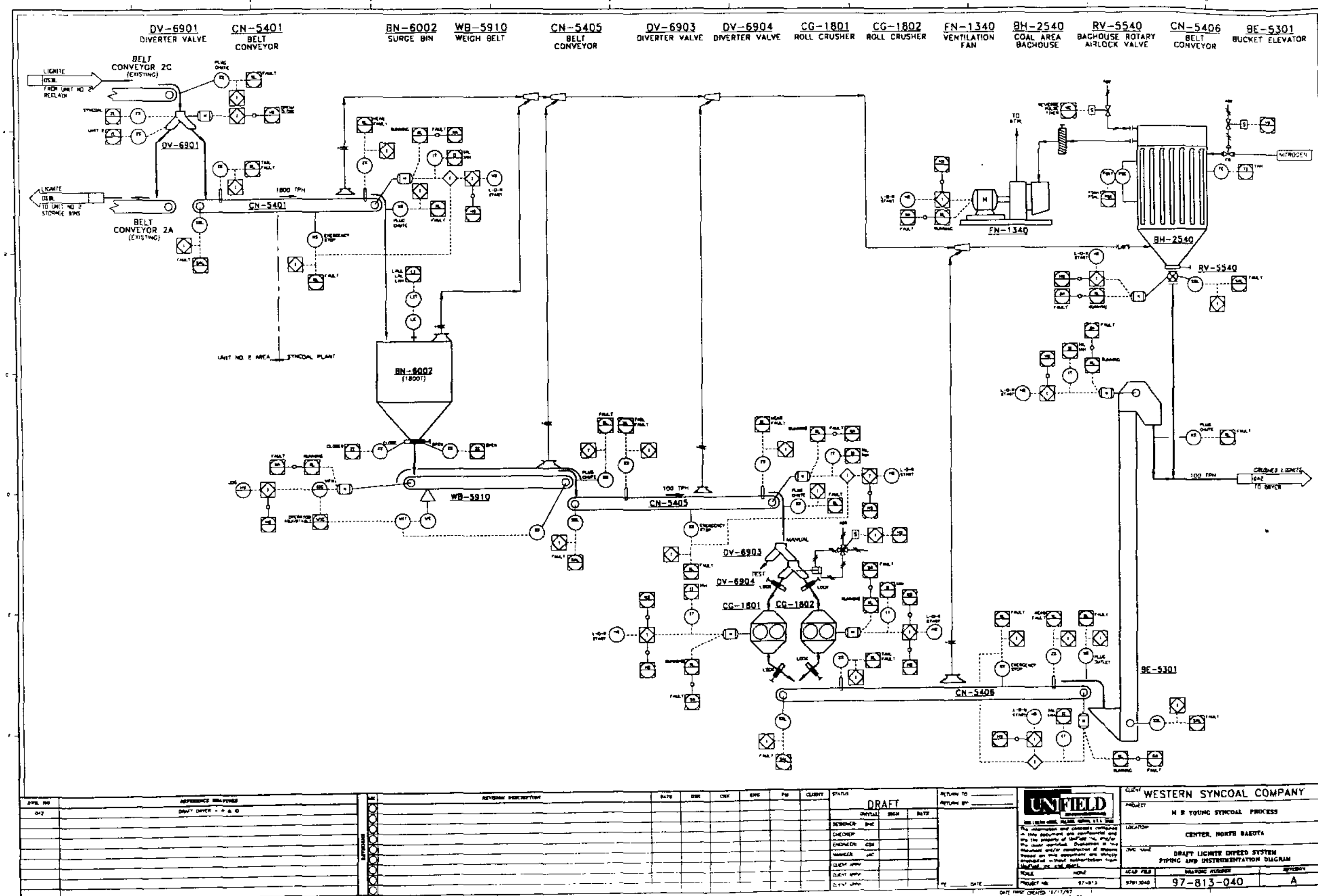


WESTERN SYNCOAL COMPANY
M R YOUNG SYNCOAL REFERENCE PLANT
CENTER, NORTH DAKOTA
DRAFT SYNCOAL PLANT SITE PLAN
97-813-005
A
PROGRESS PRINT
UNIFIELD
NOT TO SCALE
CENTER SWITCHYARD
CIRC WATER DISCHARGE
NEW ADMIN BLDG
PARKING
EXISTING BURNER CYCLONE (TYP.)
SYNCOAL SURGE BIN 22 TON (TYP.)
BIN VENT (TYP.)
UNIT 1
UNIT 2
MACHINE SHOP
CHLORINE BUILDING
UNIT 1 SCREEN HOUSE
UNIT 2 SCREEN HOUSE
NELSON LAKE
WAREHOUSE
HEATED WAREHOUSE
NAVCO WAREHOUSE
WASTE WATER TREATMENT NEUTRALIZATION BUILDING
WASTE WATER TREATMENT SEPARATIONS BUILDING
CONVEYOR 2-C
CONVEYOR 2-A
EDR BLDG
2A PRECIP
2B PRECIP
UNIT 1 PRECIP
UNIT 1 STACK
UNIT 2 STACK
UNIT 1 FLY ASH SILO
UNIT 2 FLY ASH SILO
FLY ASH SLURRY BLDG
2A ABS.
2B ABS.
CLARIF
SCRUBBER PUMPHOUSE
MAINT
DEWATERING BUILDING
2A DEMIN TANK
2B DEMIN TANK
PNEUMATIC SYNCOAL FEED LINES (3)
INFEED LIGNITE CONVEYOR STEAM SUPPLY, CONDENSATE RETURN AND GR GAS RETURN GALLERY
NEW LIGNITE BAGHOUSE
COAL SURGE BIN
CONTROL ROOM
SWITCHYARD
MCC
NEW SYNCOAL PROCESSING BUILDING
NEW SYNCOAL BAGHOUSE
UNIT 2 SYNCOAL STORAGE BIN 350 TON
UNIT 1 SYNCOAL STORAGE BIN 200 TON
SPRAY POND PUMP HOUSE
SPRAY POND
BOILER WASH PUMP HOUSE
THICKENER
VACUUM FILTER BLDG (LIME PREP)
UNITS 1 & 2 COAL TRANSFER BUILDING
UNIT 1 ACTIVE COAL STORAGE
UNIT 2 ACTIVE STORAGE BUILDING
UNIT 2 INACTIVE COAL STORAGE
UNIT 1 COAL HANDLING
UNIT 2 COAL HANDLING
225'-6"
42'-0"
23,000 N
22,500 N
147,000 E
147,500 E
148,000 E

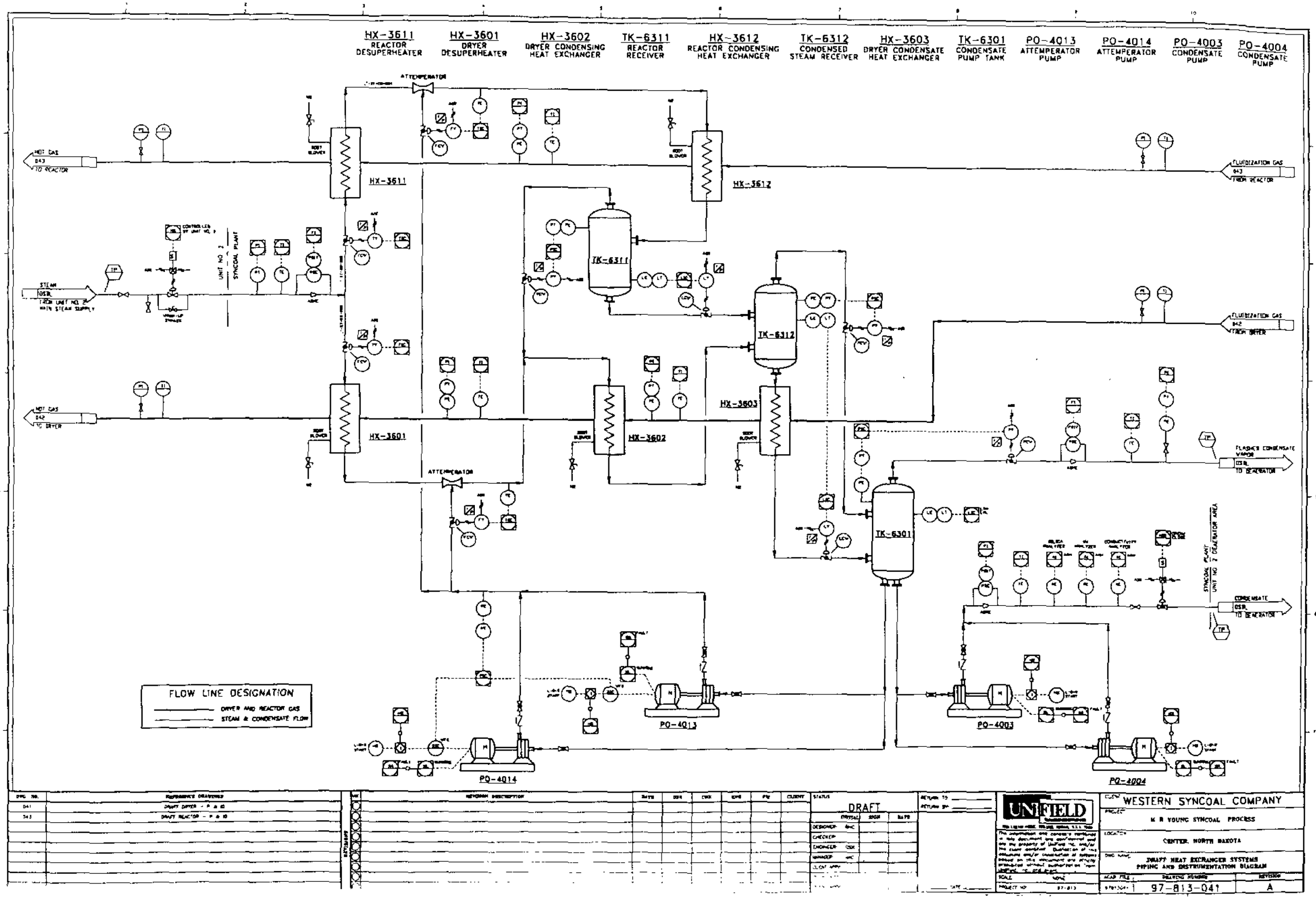

1800 TON SURGE BIN
CRUSHER
CRUSHER
3/4 INCH MINUS
BUCKET ELEVATOR
DRYER
DRYER MULTICLONE
DRYER FLUIDIZATION FAN
REACTOR FLUIDIZATION FAN
REACTOR MULTICLONE
REACTOR
NITROGEN
FROM COOLING TOWER
TO COOLING TOWER
COOLERS (2)
VIBRATORY SCREEN AND CRUSHER
+1/4 INCH
-1/4 INCH
CRUSHER
BUCKET ELEVATOR
FLOW LINE DESIGNATION
COOLER GAS
DRYER AND REACTOR GAS
STEAM & CONDENSATE FLOW
DRYER DESUPERHEATER
ATTEMPERATOR
DRYER CONDENSING HEAT EXCHANGER
DRYER SUBCOOLING HEAT EXCHANGER
REACTOR CONDENSING HEAT EXCHANGER
REACTOR DESUPERHEATER
REACTOR STEAM RECEIVER
DRYER STEAM RECEIVER
CONDENSATE RECEIVER
ATTEMPERATOR PUMP
CONDENSATE PUMP
NOTE: HEAT EXCHANGER SYSTEMS DESIGN PROVIDED BY STONE & WEBSTER ENGINEERING CORPORATION
FUTURE SYNCOAL CLEANING, STABILIZATION, STORAGE, AND LOADOUT FACILITY
PRODUCT SAMPLER
MAIN FUEL TRIP VALVE TO SECURE FUEL FLOW DURING A BOILER TRIP
SYNCOAL STORAGE BIN (2)
(350 TON FOR UNIT 2)
(200 TON FOR UNIT 1)
SYNCOAL SURGE STORAGE BIN
(22 TON TYP)
TO ATM.
INTAKE
PNEUMATIC BLOWER SYSTEM
INDIVIDUAL CYCLONE BURNER SYNCOAL FEED (TYP)
NOTE: SYNCOAL CYCLONE BURNER FEED SYSTEM DESIGN PROVIDED BY STONE & WEBSTER ENGINEERING CORPORATION
VENT GAS
TO UNIT NO 2 BOILER
EMERGENCY RELIEF TO ATM
PRIMARY AIR & LIGNITE
FROM INDIVIDUAL CYCLONE LIFT LINE
PRIMARY AIR, LIGNITE & SYNCOAL
TO CYCLONE BURNER
AT UNIT
AT SYNCOAL PLANT
LIGNITE
FROM UNIT 2 CONVEYOR 2-C
STEAM
FROM NO 2 MAIN STEAM SUPPLY
CONDENSATE
TO UNIT NO 2 DEAERATOR
VAPOR
TO UNIT NO 2 DEAERATOR HEATER
REFERENCE DRAWINGS
REVISION DESCRIPTION
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
M R YOUNG SYNCOAL REFERENCE PLANT
CENTER, NORTH DAKOTA
DRAFT PROCESS FLOW DIAGRAM
97-813-010
A


FIRST STAGE GAS
FROM FIRST STAGE BAGHOUSE
FIRST STAGE GAS
TO FIRST STAGE FLUID BED REACTOR
FIRST STAGE GAS
TO SECOND STAGE FLUID BED REACTOR
SECOND STAGE GAS
TO SECOND STAGE FLUID BED REACTOR
RECIRCULATED GAS
FROM STABILIZATION RECIRCULATION FAN
HEATED GAS
TO STABILIZATION REACTOR
FINES COOLER EXHAUST
FROM FINES ROTATING DRUM COOLER
FIRST STAGE GAS
TO GAS DISPOSAL
NOTE 1
FUEL
ASH
TO DISPOSAL
AIR
FURNACE
2nd STAGE HEAT EXCHANGER
STABILIZATION HEAT EXCHANGER
ATTEMPERATION
COOLING
BYPASS
FLOW LINE DESIGNATION
COMBUSTION GAS
FIRST STAGE GAS
SECOND STAGE GAS
STABILIZATION GAS
NOTE:
1 FUEL COULD BE ANY SUITABLE COMBUSTIBLE SUCH AS COAL, NATURAL GAS, FUEL OIL, OR BIOMASS
STABILIZATION AND CLEANING - CONCEPTUAL PROCESS FLOW DIAGRAM
STATUS
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
SYNCOAL® PROCESS
REFERENCE PLANT
FURNACE HEATING OPTION
CONCEPTUAL PROCESS FLOW DIAGRAM
97-813-011
A

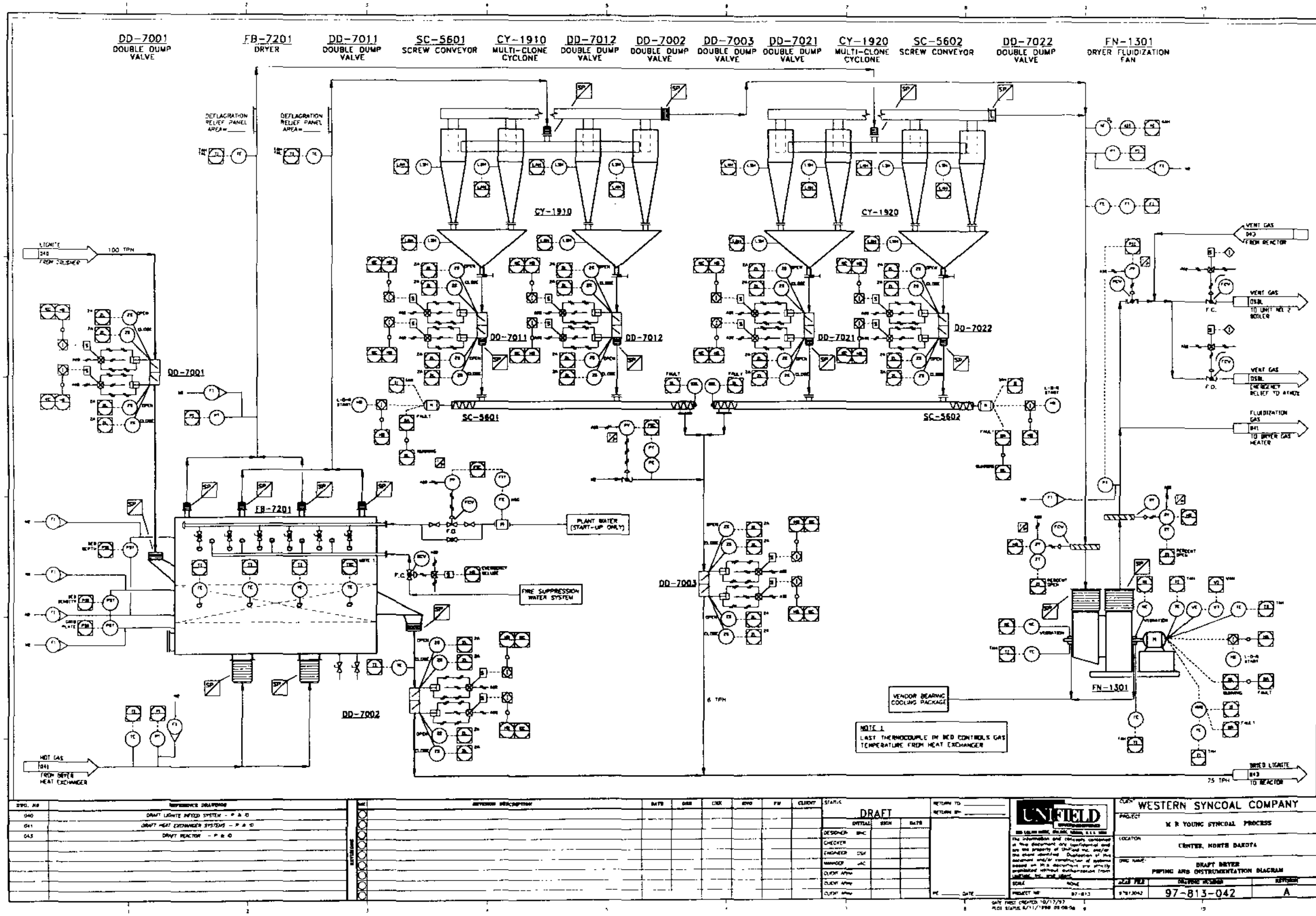

VENT GAS
RECIRCULATED GAS
TO STABILIZATION HEAT EXCHANGER
PRODUCT
FROM ROTATING DRUM COOLER
PRODUCT
FROM REACTOR
INERT GAS
HEATER GAS
FROM STABILIZATION HEAT EXCHANGER
WATER
FROM COOLING TOWER PUMP
WASTE FRACTION
TO WASTE COAL
STABILIZATION FLUID BED REACTOR
STABILIZATION COOLING FAN
STABILIZATION CYCLONE ASSEMBLY
STABILIZATION RECIRCULATING FAN
EXHAUST BAGHOUSE
REHYDRATION BELT CONVEYOR
BUCKET ELEVATOR
BELT CONVEYOR
PRODUCT CLEANING SCREEN
FINE FRACTION STONER
COARSE FRACTION STONER
COARSE FRACTION SEPARATOR
DRAG CONVEYORS
DRAG CONVEYOR
ROTATING DRUM COOLERS
COOLING WATER RETURN
COOLING WATER SUPPLY
BUCKET ELEVATOR
8-O-42
(EXIST.)
TRANSFER BELT CONVEYOR
FINES COOLER EXHAUST
INERT GAS
BYPASS FINES
TO FINES LOAD-OUT
EXHAUST TO ATMOSPHERE
VACUUM BLOWER
300 TON FINES TRUCK LOAD-OUT BIN
300 TON FINES RAIL LOAD-OUT BIN
PNEUMATIC TRANSFER
TRUCK LOAD-OUT
RAIL LOAD-OUT
PRODUCT
TRUCK LOAD-OUT
AIR
FLOW LINE DESIGNATION
FIRST STAGE GAS
SECOND STAGE GAS
STABILIZATION GAS
REFERENCE DRAWINGS
FURNACE HEATING OPTION - CONCEPTUAL PROCESS FLOW DIAGRAM
REVISION DESCRIPTION
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
SYNCOAL PROCESS
REFERENCE PLANT
STABILIZATION REHYDRATION AND CLEANING CONCEPTUAL PROCESS FLOW DIAGRAM
97-813-012
A



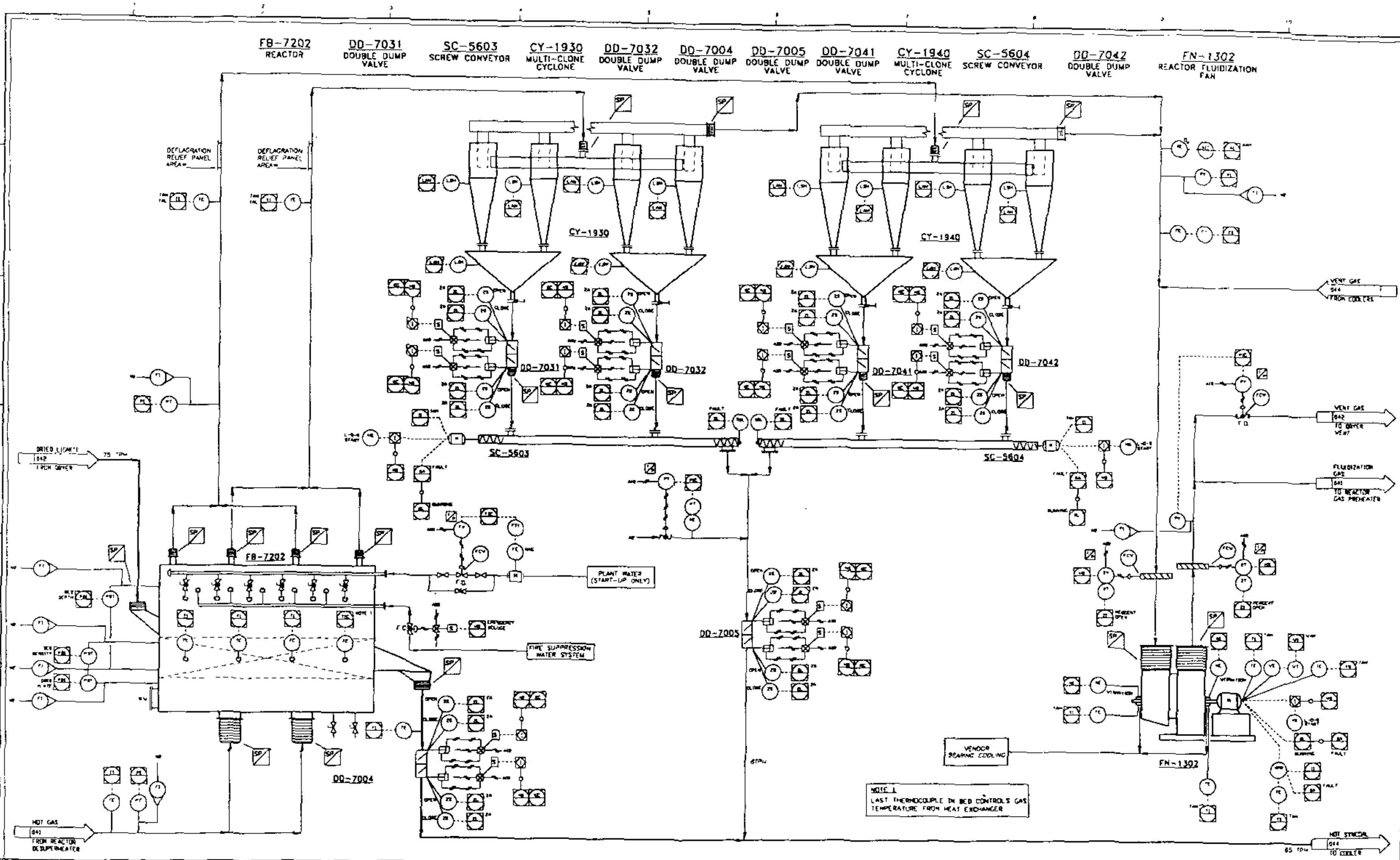
DV-6901 DIVERTER VALVE
CN-5401 BELT CONVEYOR
BN-6002 SURGE BIN
WB-5910 WEIGH BELT
CN-5405 BELT CONVEYOR
DV-6903 DIVERTER VALVE
DV-6904 DIVERTER VALVE
CG-1801 ROLL CRUSHER
CG-1802 ROLL CRUSHER
FN-1340 VENTILATION FAN
BH-2540 COAL AREA BAGHOUSE
RV-5540 BAGHOUSE ROTARY AIRLOCK VALVE
CN-5406 BELT CONVEYOR
BE-5301 BUCKET ELEVATOR
BELT CONVEYOR 2C (EXISTING)
BELT CONVEYOR 2A (EXISTING)
1800 TPH
100 TPH
UNIT NO 2 AREA
SYNCOAL PLANT
BN-6002 (1800T)
NITROGEN
TO ATM.
CRUSHED LIGNITE TO DRYER
MANUAL
TEST
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
M R YOUNG SYNCOAL PROCESS
CENTER, NORTH DAKOTA
DRAFT LIGNITE INFEED SYSTEM PIPING AND INSTRUMENTATION DIAGRAM
97-813-040
A



HX-3611 REACTOR DESUPERHEATER
HX-3601 DRYER DESUPERHEATER
HX-3602 DRYER CONDENSING HEAT EXCHANGER
TK-6311 REACTOR RECEIVER
HX-3612 REACTOR CONDENSING HEAT EXCHANGER
TK-6312 CONDENSED STEAM RECEIVER
HX-3603 DRYER CONDENSATE HEAT EXCHANGER
TK-6301 CONDENSATE PUMP TANK
PO-4013 ATTEMPERATOR PUMP
PO-4014 ATTEMPERATOR PUMP
PO-4003 CONDENSATE PUMP
PO-4004 CONDENSATE PUMP
ATTEMPERATOR
HOT GAS 043 TO REACTOR
HOT GAS 042 TO DRYER
STEAM OSR. FROM UNIT NO. 2 MAIN STEAM SUPPLY
UNIT NO. 2
SYNCOAL PLANT
FLUIDIZATION GAS 043 FROM REACTOR
FLUIDIZATION GAS 042 FROM DRYER
FLASHED CONDENSATE VAPOR OSR. TO DEAERATOR
CONDENSATE OSR. TO DEAERATOR
SYNCOAL PLANT
UNIT NO 2 DEAERATOR AREA
FLOW LINE DESIGNATION
DRYER AND REACTOR GAS
STEAM & CONDENSATE FLOW
REFERENCE DRAWINGS
DRAFT DRYER - P & ID
DRAFT REACTOR - P & ID
REVISION DESCRIPTION
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
K R YOUNG SYNCOAL PROCESS
CENTER, NORTH DAKOTA
DRAFT HEAT EXCHANGER SYSTEMS
PIPING AND INSTRUMENTATION DIAGRAM
97-813-041
A



DD-7001 DOUBLE DUMP VALVE
FB-7201 DRYER
DD-7011 DOUBLE DUMP VALVE
SC-5601 SCREW CONVEYOR
CY-1910 MULTI-CLONE CYCLONE
DD-7012 DOUBLE DUMP VALVE
DD-7002 DOUBLE DUMP VALVE
DD-7003 DOUBLE DUMP VALVE
DD-7021 DOUBLE DUMP VALVE
CY-1920 MULTI-CLONE CYCLONE
SC-5602 SCREW CONVEYOR
DD-7022 DOUBLE DUMP VALVE
FN-1301 DRYER FLUIDIZATION FAN
DEFLAGRATION RELIEF PANEL AREA=
LIGNITE 040 FROM CRUSHER
100 TPH
HOT GAS 041 FROM DRYER HEAT EXCHANGER
PLANT WATER (START-UP ONLY)
FIRE SUPPRESSION WATER SYSTEM
6 TPH
VENDOR BEARING COOLING PACKAGE
NOTE 1
LAST THERMOCOUPLE IN BED CONTROLS GAS TEMPERATURE FROM HEAT EXCHANGER
VENT GAS 043 FROM REACTOR
VENT GAS DSBL TO UNIT NO. 2 BOILER
VENT GAS DSBL EMERGENCY RELIEF TO ATMOS
FLUIDIZATION GAS 041 TO DRYER GAS HEATER
DRIED LIGNITE 043 TO REACTOR
75 TPH
REFERENCE DRAWINGS
040 DRAFT LIGNITE INFEED SYSTEM - P & ID
041 DRAFT HEAT EXCHANGER SYSTEMS - P & ID
043 DRAFT REACTOR - P & ID
REVISION DESCRIPTION
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
K R YOUNG SYNCOAL PROCESS
CENTER, NORTH DAKOTA
DRAFT DRYER PIPING AND INSTRUMENTATION DIAGRAM
97-813-042
A



DWG NO	REFERENCE DRAWINGS
041	DRAFT HEAT EXCHANGER SYSTEMS - P & ID
042	DRAFT DRYER - P & ID
044	DRAFT COOLER - P & ID

REVISION DESCRIPTION

STATUS: DRAFT

	INITIAL	SIGN	DATE
DESIGNER	BHC		
CHECKER			
ENGINEER	CSA		
MANAGER	JAC		
CLIENT APPR			
CLIENT APPR			
CLIENT APPR			

UNIFIELD

CLIENT: WESTERN SYNCOAL COMPANY

PROJECT: K R YOUNG SYNCOAL PROCESS

LOCATION: CENTER, NORTH DAKOTA

DWG NAME: DRAFT REACTOR PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NONE

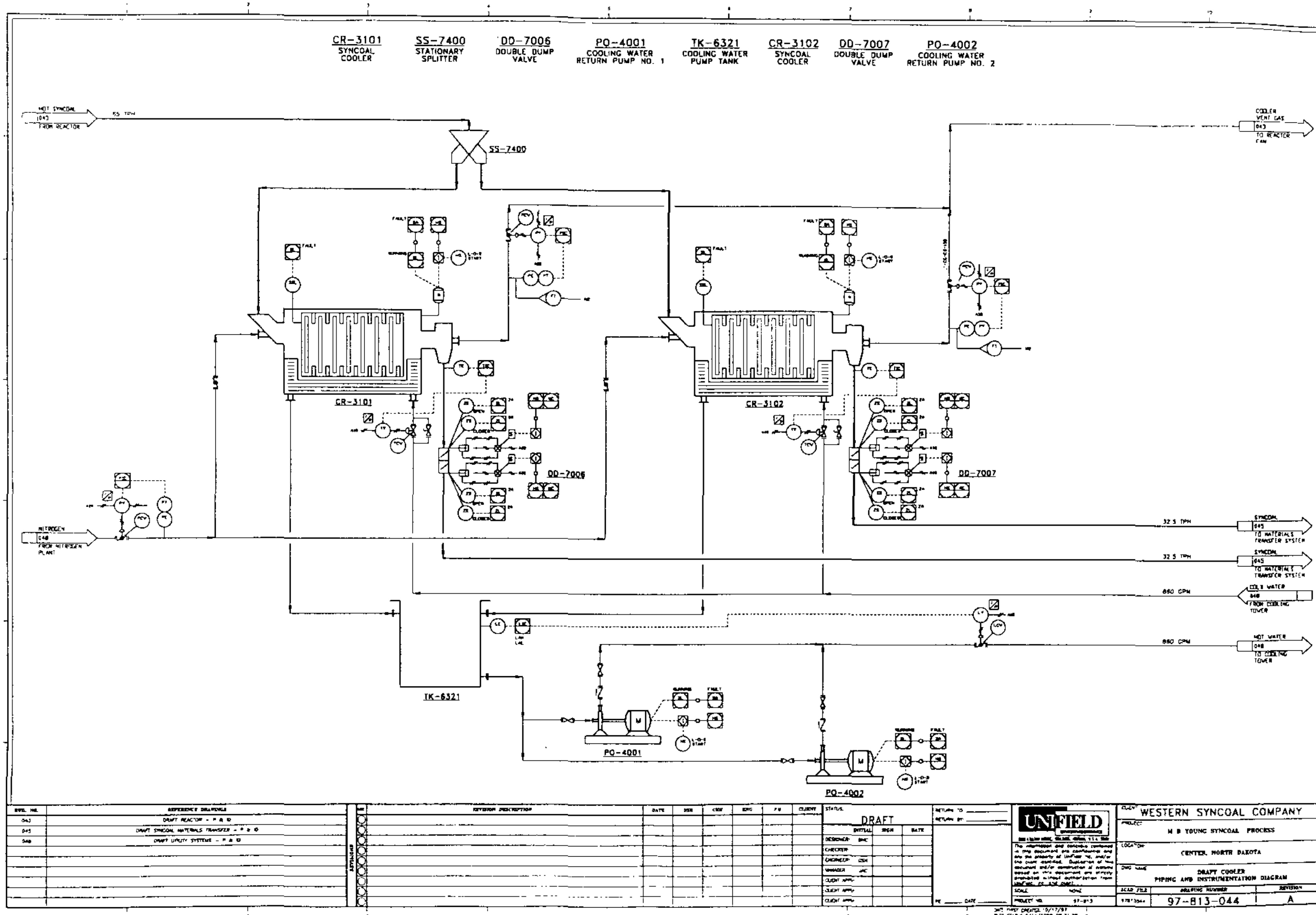
PROJECT NO: 97-813

CAD FILE: 97813043

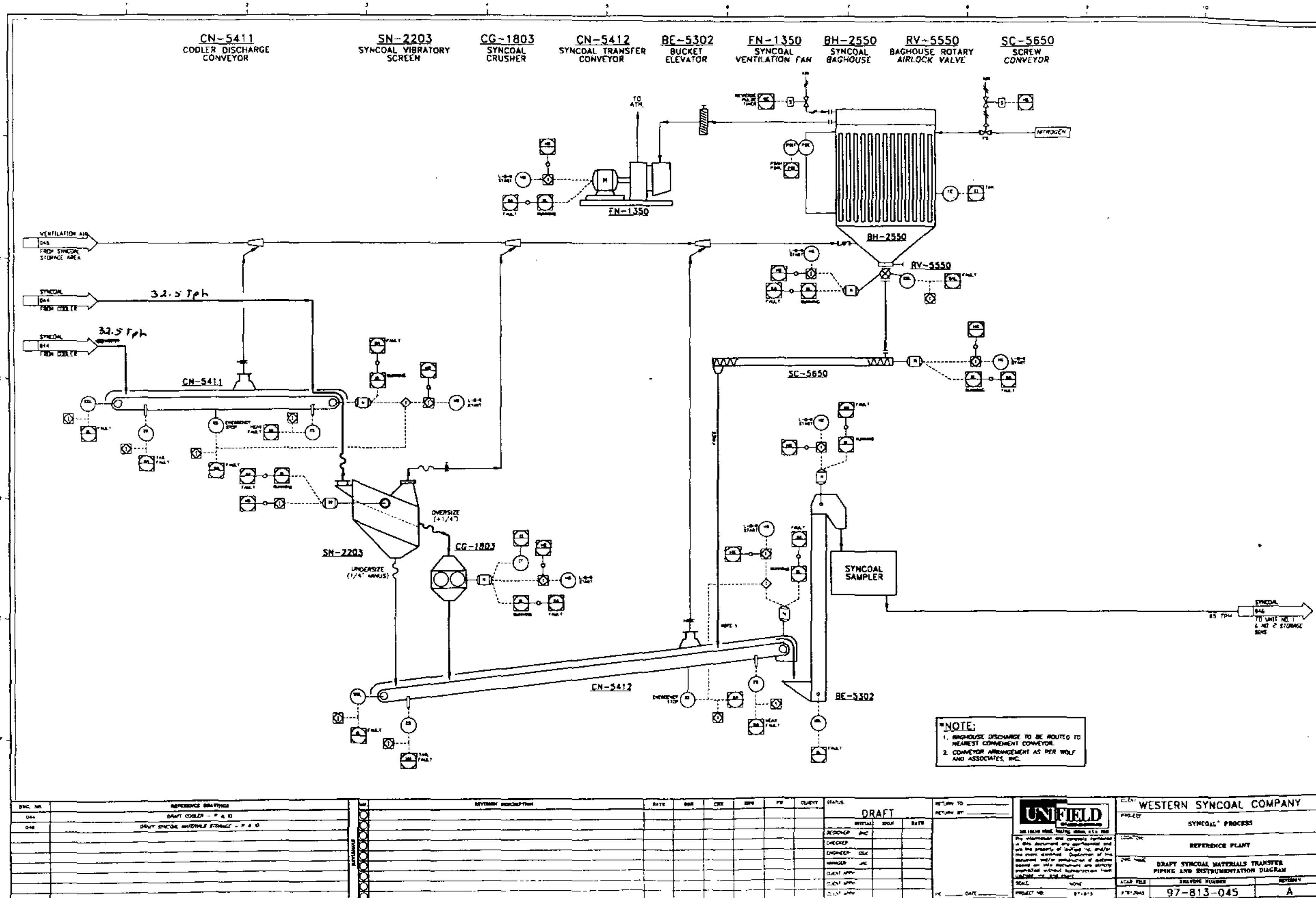
DRAWING NUMBER: 97-813-043

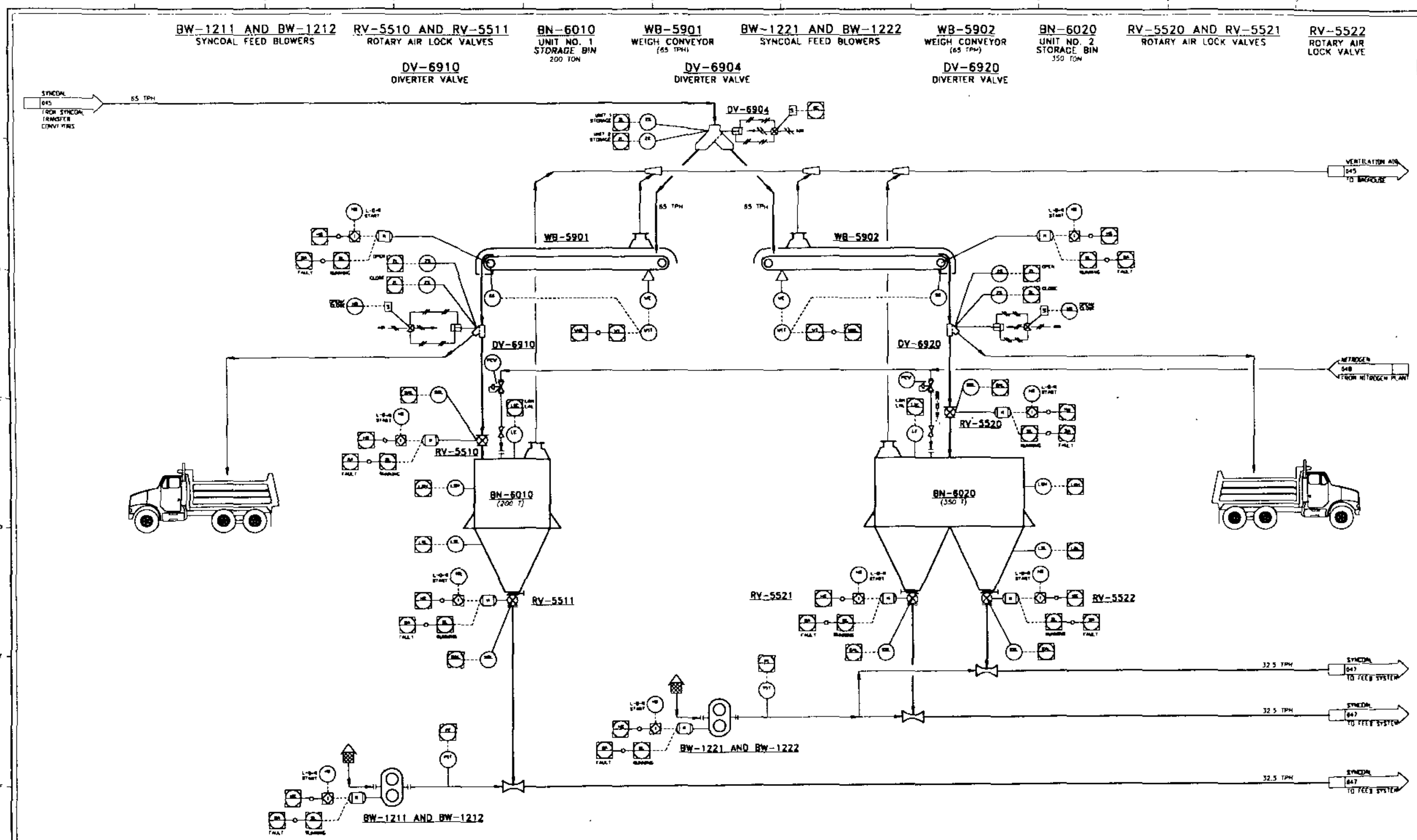
REVISION: A

G:\97-813\97E 43 DWG Thu Jun 11 09 53 41 1998



CR-3101 SYNCOAL COOLER
SS-7400 STATIONARY SPLITTER
DD-7006 DOUBLE DUMP VALVE
PO-4001 COOLING WATER RETURN PUMP NO. 1
TK-6321 COOLING WATER PUMP TANK
CR-3102 SYNCOAL COOLER
DD-7007 DOUBLE DUMP VALVE
PO-4002 COOLING WATER RETURN PUMP NO. 2
HOT SYNCOAL 043 FROM REACTOR
55 TPH
SS-7400
COOLER VENT GAS 043 TO REACTOR FAN
CR-3101
CR-3102
DD-7006
DD-7007
NITROGEN 048 FROM NITROGEN PLANT
32.5 TPH
SYNCOAL 045 TO MATERIALS TRANSFER SYSTEM
32.5 TPH
SYNCOAL 045 TO MATERIALS TRANSFER SYSTEM
660 GPM
COLD WATER 048 FROM COOLING TOWER
660 GPM
HOT WATER 048 TO COOLING TOWER
TK-6321
PO-4001
PO-4002
REFERENCE DRAWINGS
DRAFT REACTOR - P & ID
DRAFT SYNCOAL MATERIALS TRANSFER - P & ID
DRAFT UTILITY SYSTEMS - P & ID
REVISION DESCRIPTION
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
M B YOUNG SYNCOAL PROCESS
CENTER, NORTH DAKOTA
DRAFT COOLER
PIPING AND INSTRUMENTATION DIAGRAM
97-813-044
A


CN-5411
COOLER DISCHARGE CONVEYOR
SN-2203
SYNCOAL VIBRATORY SCREEN
CG-1803
SYNCOAL CRUSHER
CN-5412
SYNCOAL TRANSFER CONVEYOR
BE-5302
BUCKET ELEVATOR
FN-1350
SYNCOAL VENTILATION FAN
BH-2550
SYNCOAL BAGHOUSE
RV-5550
BAGHOUSE ROTARY AIRLOCK VALVE
SC-5650
SCREW CONVEYOR
TO ATM.
NITROGEN
VENTILATION AIR
FROM SYNCOAL STORAGE AREA
SYNCOAL
FROM COOLER
32.5 Tph
32.5 Tph
OVERSIZE (+1/4")
UNDERSIZE (1/4" MINUS)
SYNCOAL SAMPLER
SYNCOAL
TO UNIT NO. 1 & NO. 2 STORAGE BINS
*NOTE:
1. BAGHOUSE DISCHARGE TO BE ROUTED TO NEAREST CONVENIENT CONVEYOR.
2. CONVEYOR ARRANGEMENT AS PER WOLF AND ASSOCIATES, INC.
REFERENCE DRAWINGS
DRAFT COOLER - P & ID
DRAFT SYNCOAL MATERIALS STORAGE - P & ID
REVISION DESCRIPTION
DRAFT
UNIFIELD
WESTERN SYNCOAL COMPANY
SYNCOAL PROCESS
REFERENCE PLANT
DRAFT SYNCOAL MATERIALS TRANSFER PIPING AND INSTRUMENTATION DIAGRAM
97-813-045
A



DWG. NO.	REFERENCE DRAWINGS
045	DRAFT SYNCOAL MATERIALS TRANSFER - P & ID
047	DRAFT SYNCOAL FEED SYSTEM - P & ID
048	DRAFT UTILITY SYSTEMS - P & ID

STATUS: DRAFT

	INITIAL	SIGN	DATE
DESIGNER	BHE		
CHECKER			
ENGINEER	GSK		
MANAGER	JAC		
CLIENT APPV			
CLIENT APPV			
CLIENT APPV			

UNIFIELD

CLIENT: WESTERN SYNCOAL COMPANY

PROJECT: SYNCOAL® PROCESS

LOCATION: REFERENCE PLANT

DWG. NAME: DRAFT SYNCOAL MATERIALS STORAGE PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NONE

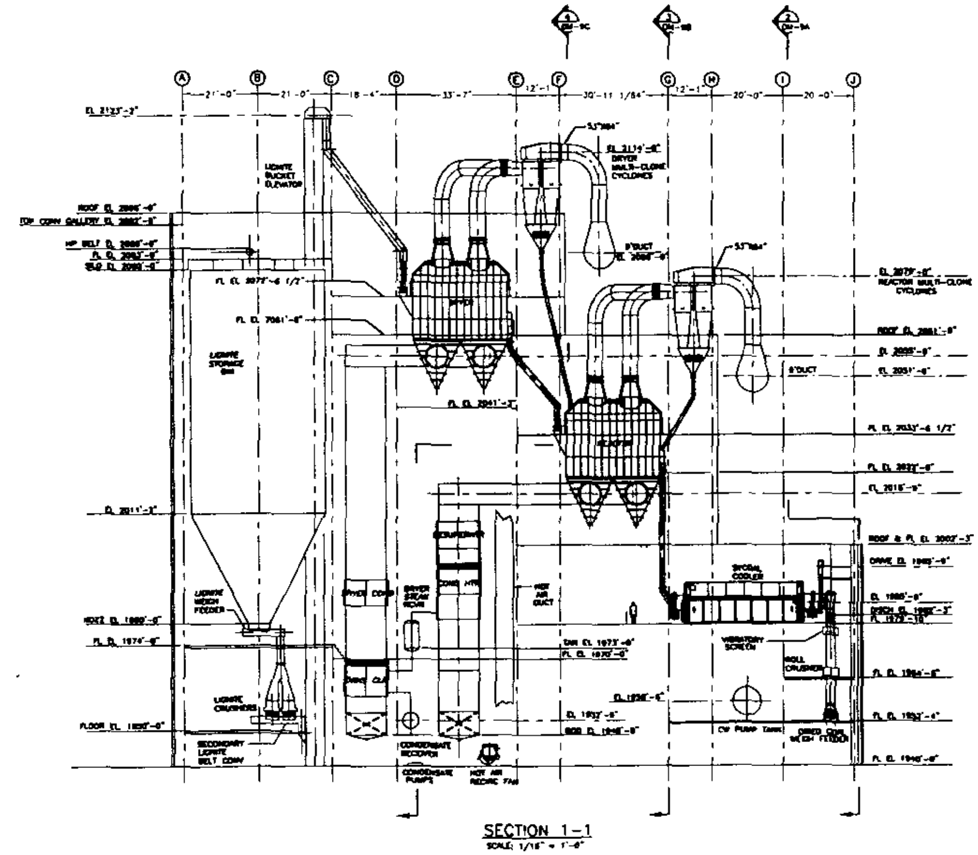
PROJECT NO. 97-813

DRAWING NUMBER: 97-813-046

REVISION: A

DATE FIRST CREATED 10/17/97

G:\97-813\971 46 DWG Thu Jun 11 10 17 08 1998

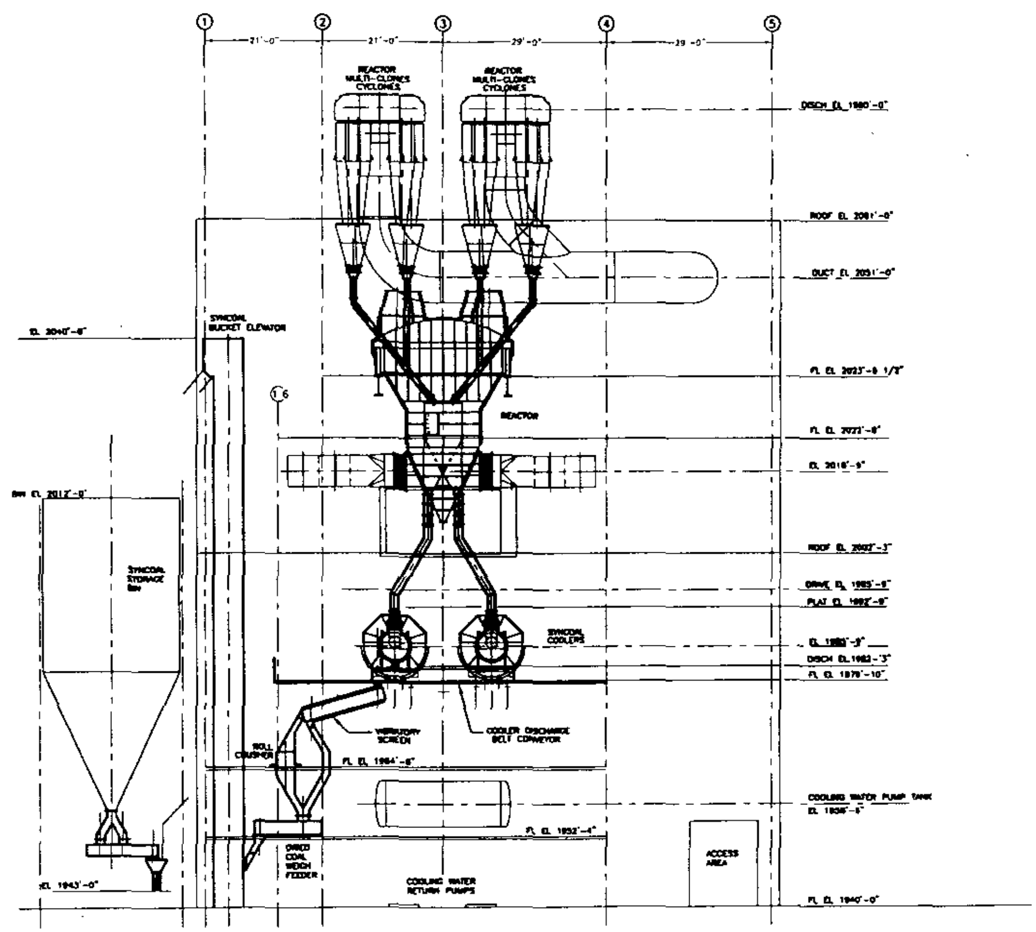


DWG NO	REFERENCE DRAWINGS
DM-BA-A	GENERAL ARRANGEMENT - PROCESS AREA - ELEVATION LOOKING EAST

	INITIAL	SIGN	DATE
DESIGNER	EMB		
CHECKER			
ENGINEER	CSH		
MANAGER	JAC		
CLIENT APPR			
CLIENT APPR			
CLIENT APPR			

UNIFIELD

CLIENT: WESTERN SYNCOAL COMPANY
PROJECT: M R YOUNG SYNCOAL PROCESS
LOCATION: CENTER, NORTH DAKOTA
DWG NAME: GENERAL ARRANGEMENT PROCESS AREA - ELEVATION LOOKING EAST
SCALE: AS NOTED
DRAWING NUMBER: 97-B13-070



SECTION 1-1 - LOOKING NORTH

SCALE: 1"=10'

DWG. NO.	REFERENCE DRAWINGS
DW-98-A	PROCESS AREA - ELEVATION LOOKING NORTH

REV	REVISION DESCRIPTION	DATE	DRN	CHK	ENG	PM	CLIENT

STATUS

	INITIAL	SIGN	DATE
DESIGNER	EPB		
CHECKER			
ENGINEER	CSK		
MANAGER	JAC		
CLIENT APPV			
CLIENT APPV			
CLIENT APPV			

RETURN TO

RETURN BY

PE ____ DATE ____

UNIFIELD

SCALE: AS NOTED

PROJECT NO. 97-813

CLIENT: WESTERN SYCOAL COMPANY

PROJECT: N R YOUNG SYNCOAL PROCESS

LOCATION: CENTER, NORTH DAKOTA

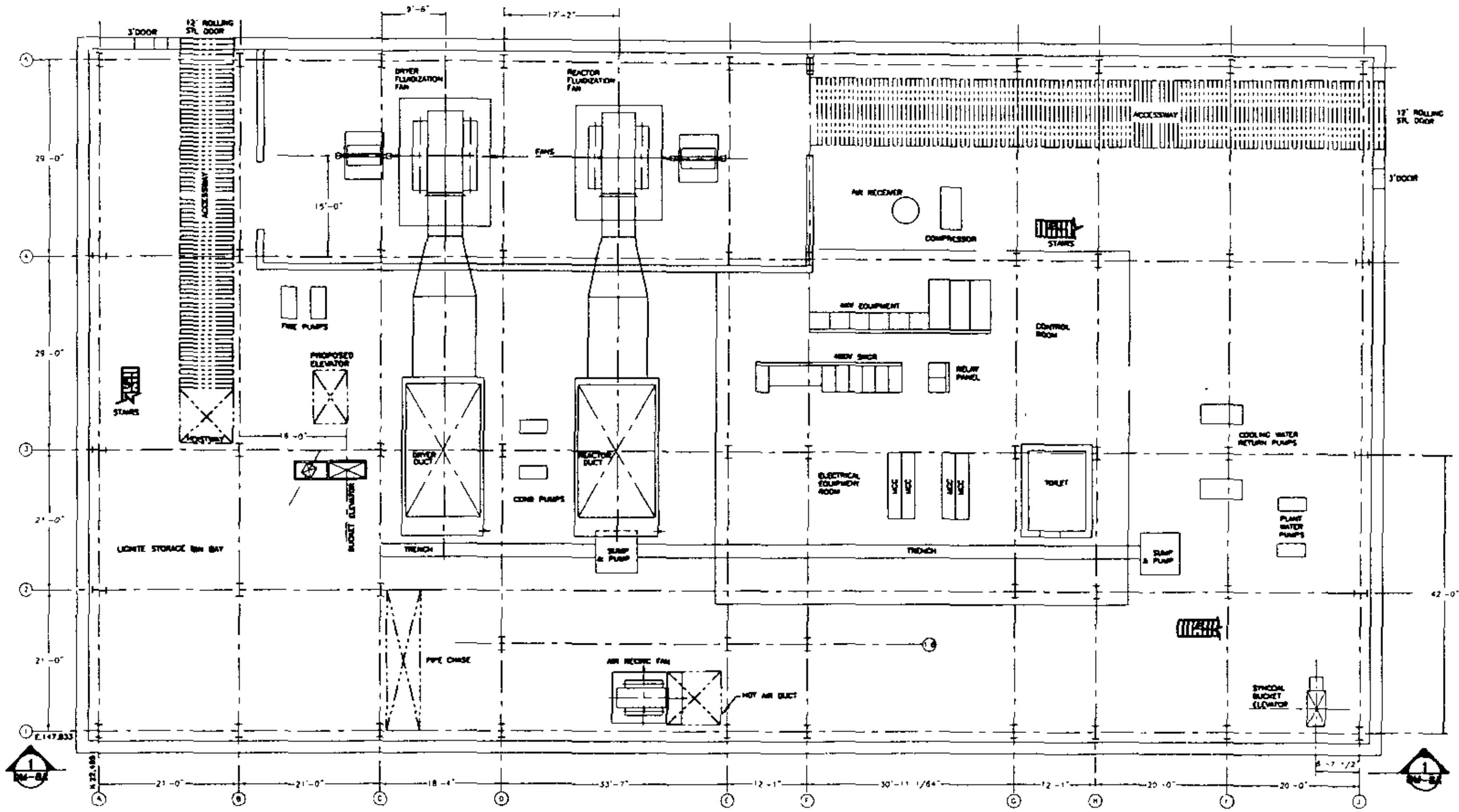
DWG NAME: PROCESS AREA ELEVATION - LOOKING NORTH

ACAD FILE: 9781307

DRAWING NUMBER: 97-813-071

REVISION

DATE FIRST CREATED 10/31/97



PROCESS AREA - PLAN

SCALE: 1/8"=1'-0"

DWG. NO	REFERENCE DRAWINGS
DM-14-A	GENERAL ARRANGEMENT - PROCESS AREA - GROUND FLOOR PLAN @ EL 0'-0"

REV	REVISION DESCRIPTION	DATE	DSN	CHK	ENG	PM	CLIENT

STATUS

	INITIAL	SIGN	DATE
DESIGNER	CPB		
CHECKER			
ENGINEER	SSK		
MANAGER	JAC		

RETURN TO
RETURN BY

UNIFIELD

CLIENT: WESTERN SYNCOAL COMPANY

PROJECT: W R YOUNG SYNCOAL PROCESS

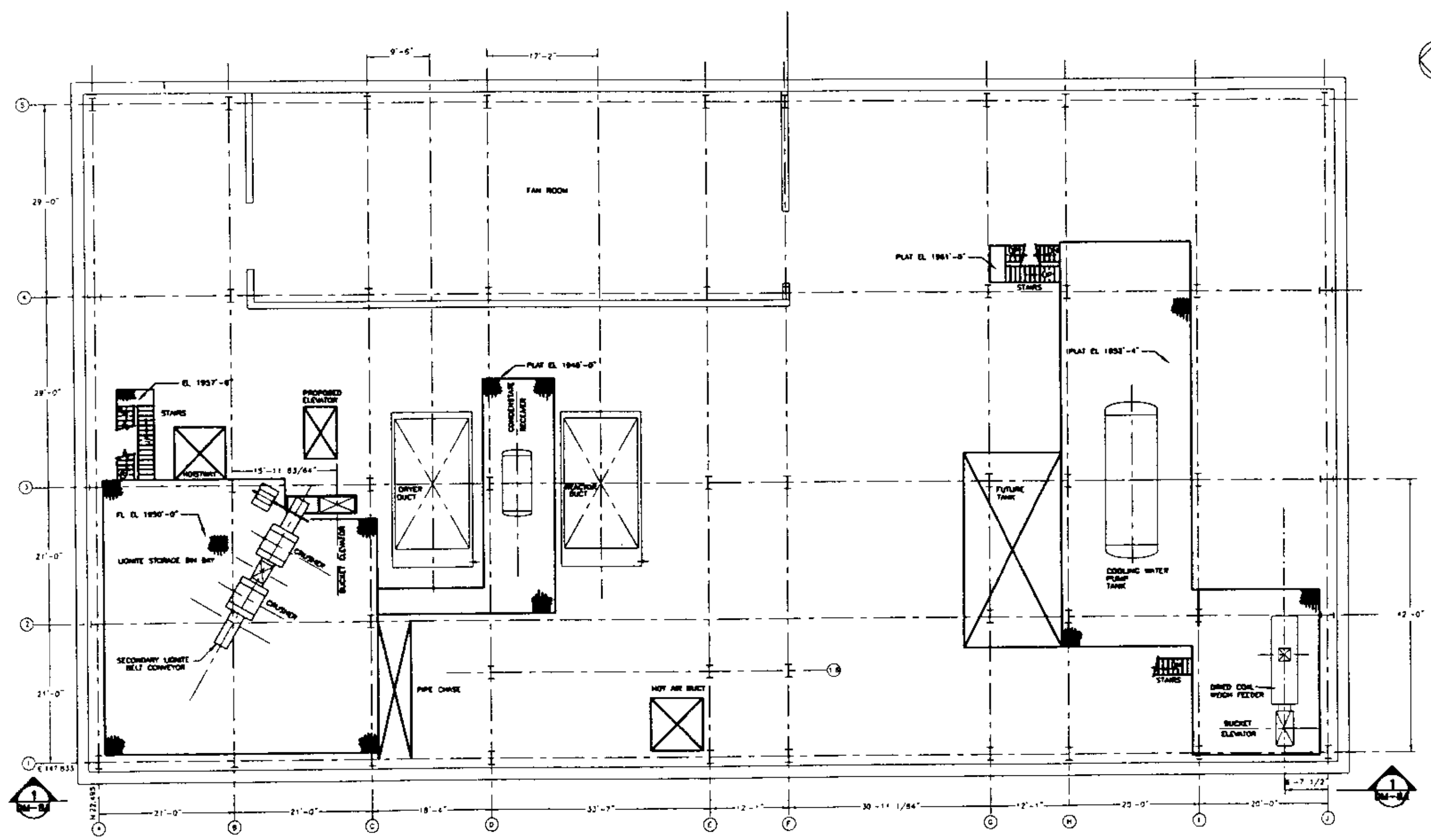
LOCATION: CENTER, NORTH DAKOTA

DWG NAME: GENERAL ARRANGEMENT - PROCESS AREA GROUND FLOOR PLAN @ EL 0'-0"

SCALE: AS NOTED

DRAWING NUMBER: 97-813-072

G:\97-813\978'. 2 DWG Wed Jun 10 09 13 54 1998



PROCESS AREA – PLAN

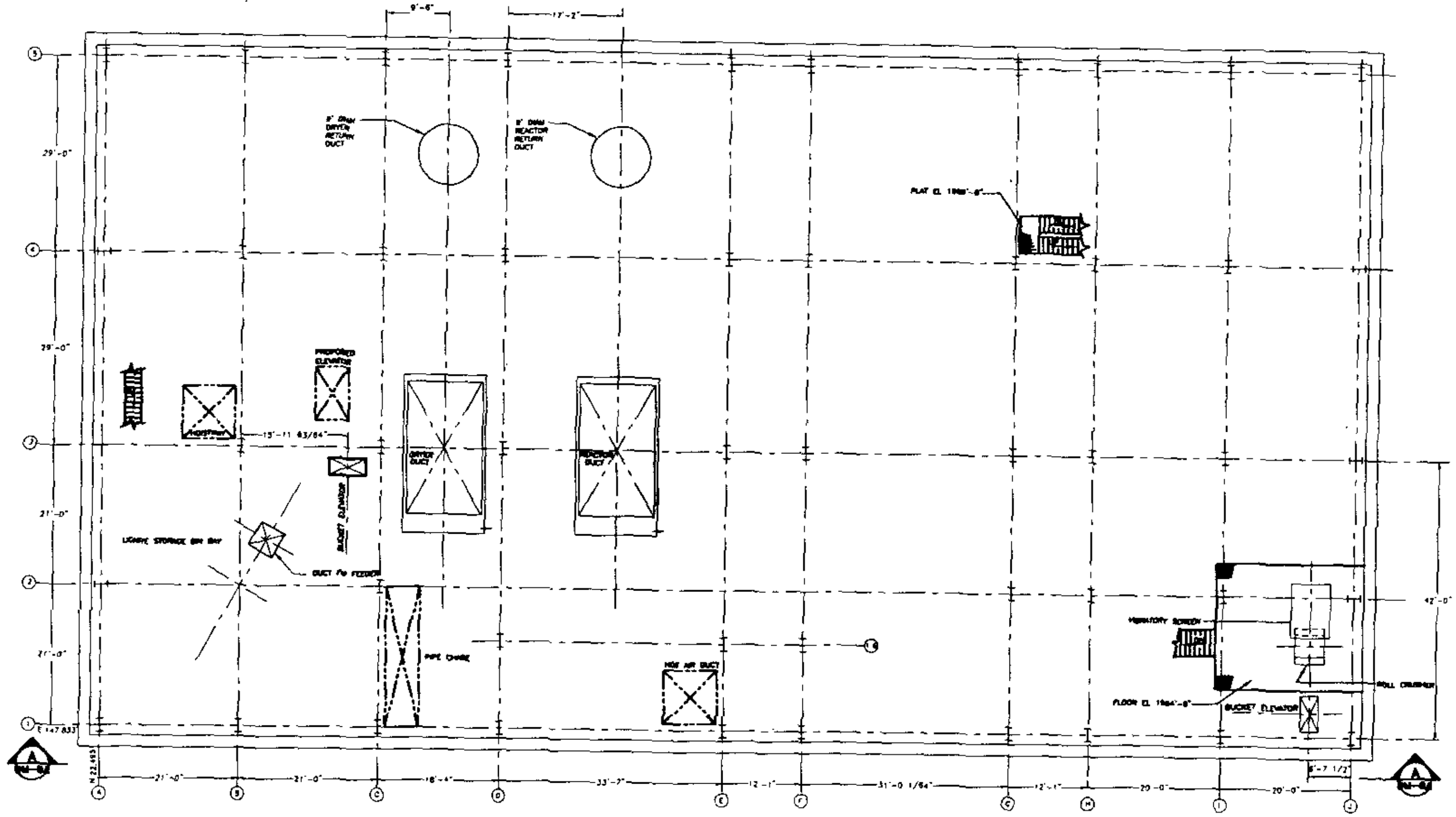
SCALE: 1/8"=1'-0"

DWG. NO.	REFERENCE DRAWINGS
DM-26-A	GENERAL ARRANGEMENT – PROCESS AREA – PLAN @ EL 12'-4"

CLIENT	WESTERN SYNCOAL COMPANY
PROJECT	M R YOUNG SYNCOAL PROCESS
LOCATION	CENTER, NORTH DAKOTA
DWG NAME	GENERAL ARRANGEMENT – PROCESS AREA PLAN @ EL 12'-4"
DRAWING NUMBER	97-813-073
SCALE	AS NOTED
PROJECT NO	97-813

UNIFIELD

G \97-813\9/8\ .3.DWG Wed Jun 10 09 15 18 1998



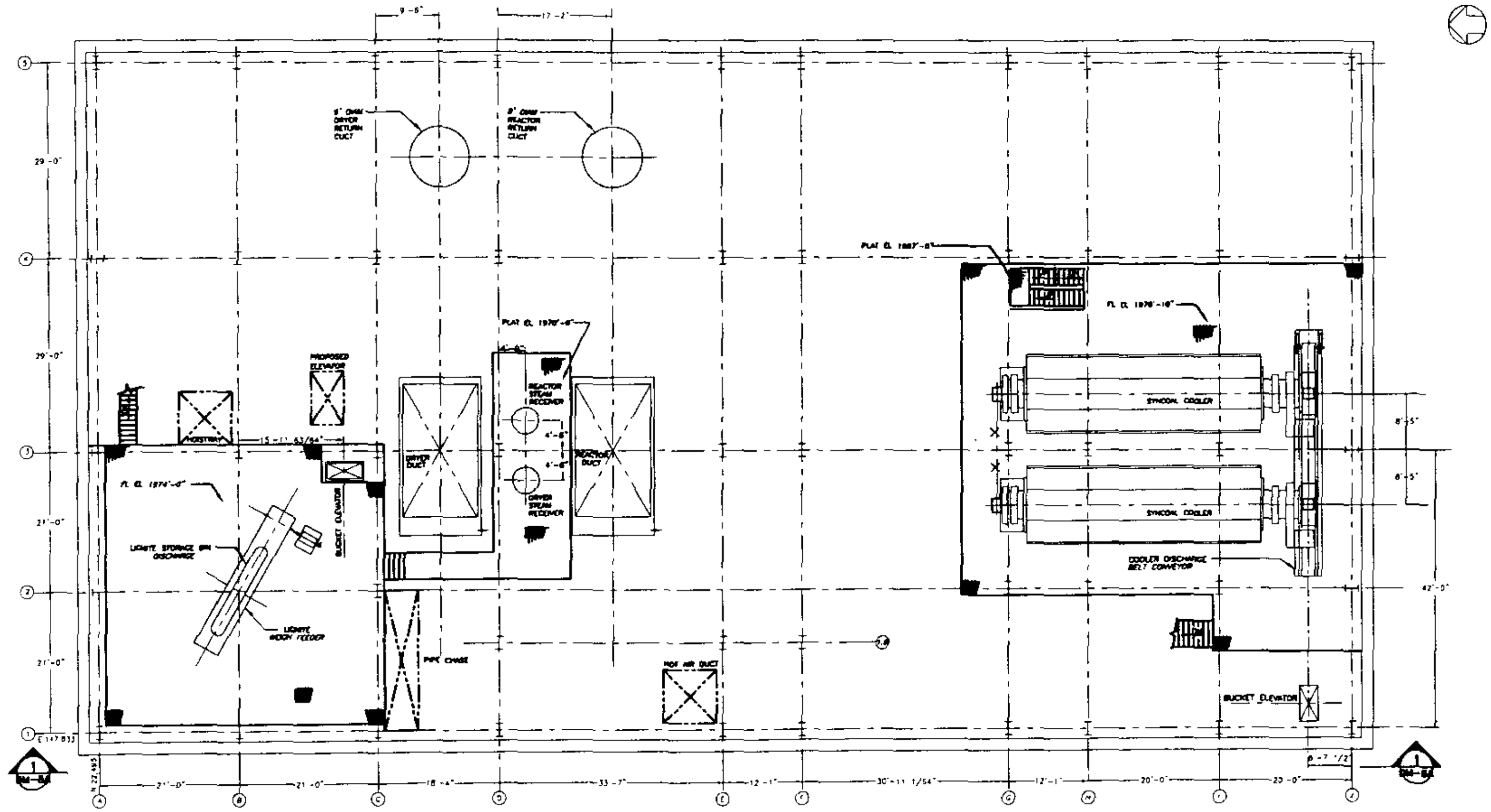
PROCESS AREA - PLAN

SCALE: 1/8"=1'-0"

DWG. NO	REFERENCE DRAWINGS
04-29-A	GENERAL ARRANGEMENT - PROCESS AREA - PLAN @ EL 34'-8"

UNIFIELD

CLIENT	WESTERN SYNCOAL COMPANY
PROJECT	N R YOUNG SYNCOAL PROCESS
LOCATION	CENTER, NORTH DAKOTA
DWG NAME	GENERAL ARRANGEMENT - PROCESS AREA PLAN @ EL 24'-8"
DRAWING NUMBER	97-813-074



PROCESS AREA - PLAN

SCALE: 1/8"=1'-0"

DWG. NO.	REFERENCE DRAWINGS
2M-3A-4	GENERAL ARRANGEMENT - PROCESS AREA - PLAN @ EL 34'-0" & 38'-6"

STATUS	INITIAL	SIGN	DATE
DESIGNER	CMB		
CHECKER			
ENGINEER	CSH		
MANAGER	JAC		
CLIENT APPV			
CLIENT APPV			

UNIFIELD

CLIENT: WESTERN SYNCOAL COMPANY

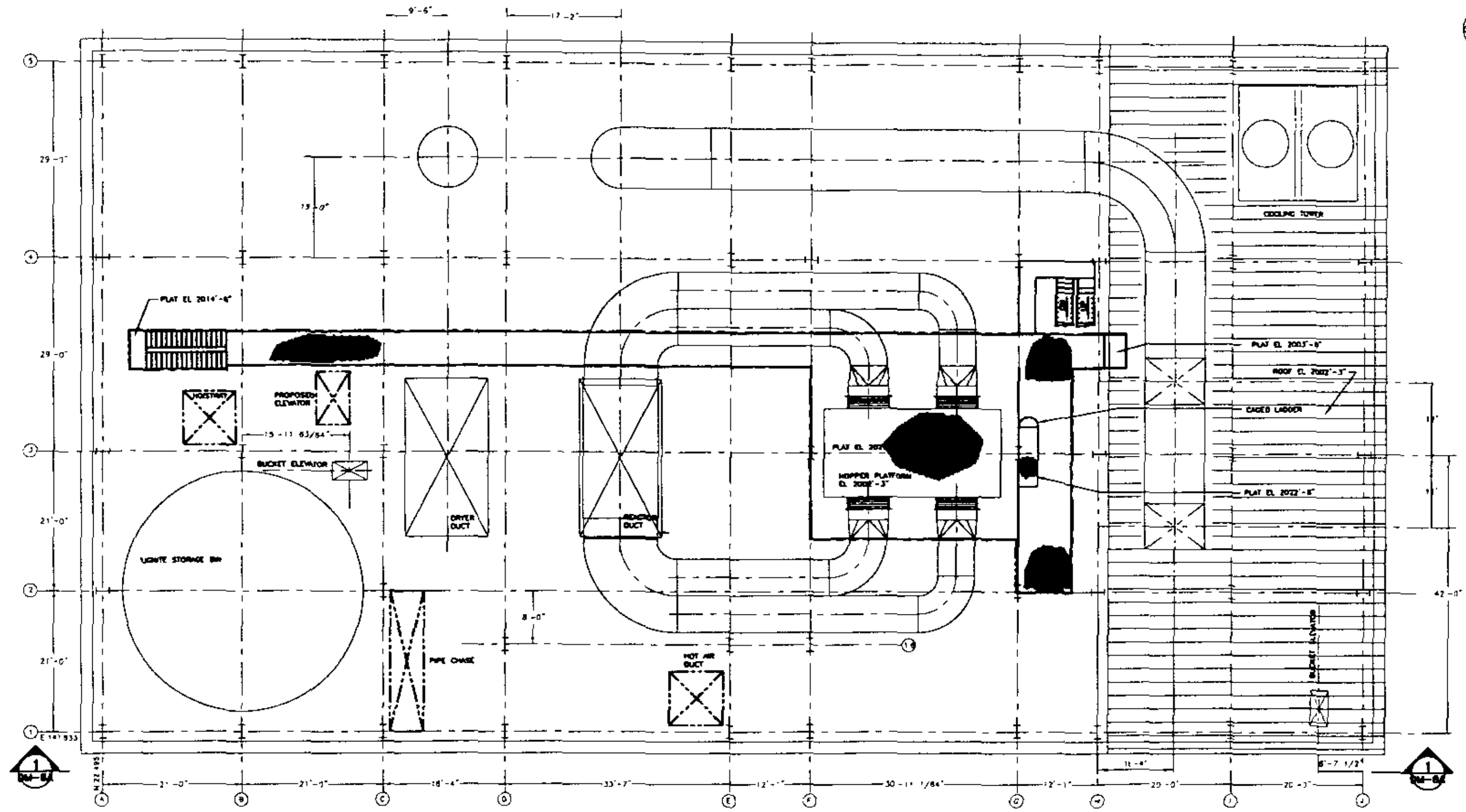
PROJECT: M R YOUNG SYNCOAL PROCESS

LOCATION: CENTER, NORTH DAKOTA

DWG NAME: GENERAL ARRANGEMENT - PROCESS AREA PLAN @ EL 34'-0" & 38'-6"

SCALE: AS NOTED

DRAWING NUMBER: 97-B13-075



PROCESS AREA – PLAN VIEW

SCALE: 1/8"=1'-0"

DWG NO	REFERENCE DRAWINGS
DM-AA-4	GENERAL ARRANGEMENT - PROCESS AREA - PLAN @ 82'-3" & 66'-8"

REVISION DESCRIPTION | DATE | BY | CHK | ENG | PM | CLIENT

STATUS — INITIAL / ENGR / DATE — DESIGNER / CHECKER / ENGINEER / MANAGER / CLIENT APPR

UNIFIELD

CLIENT: WESTERN SYNCOAL COMPANY

PROJECT: W R YOUNG SYNCOAL PROCESS

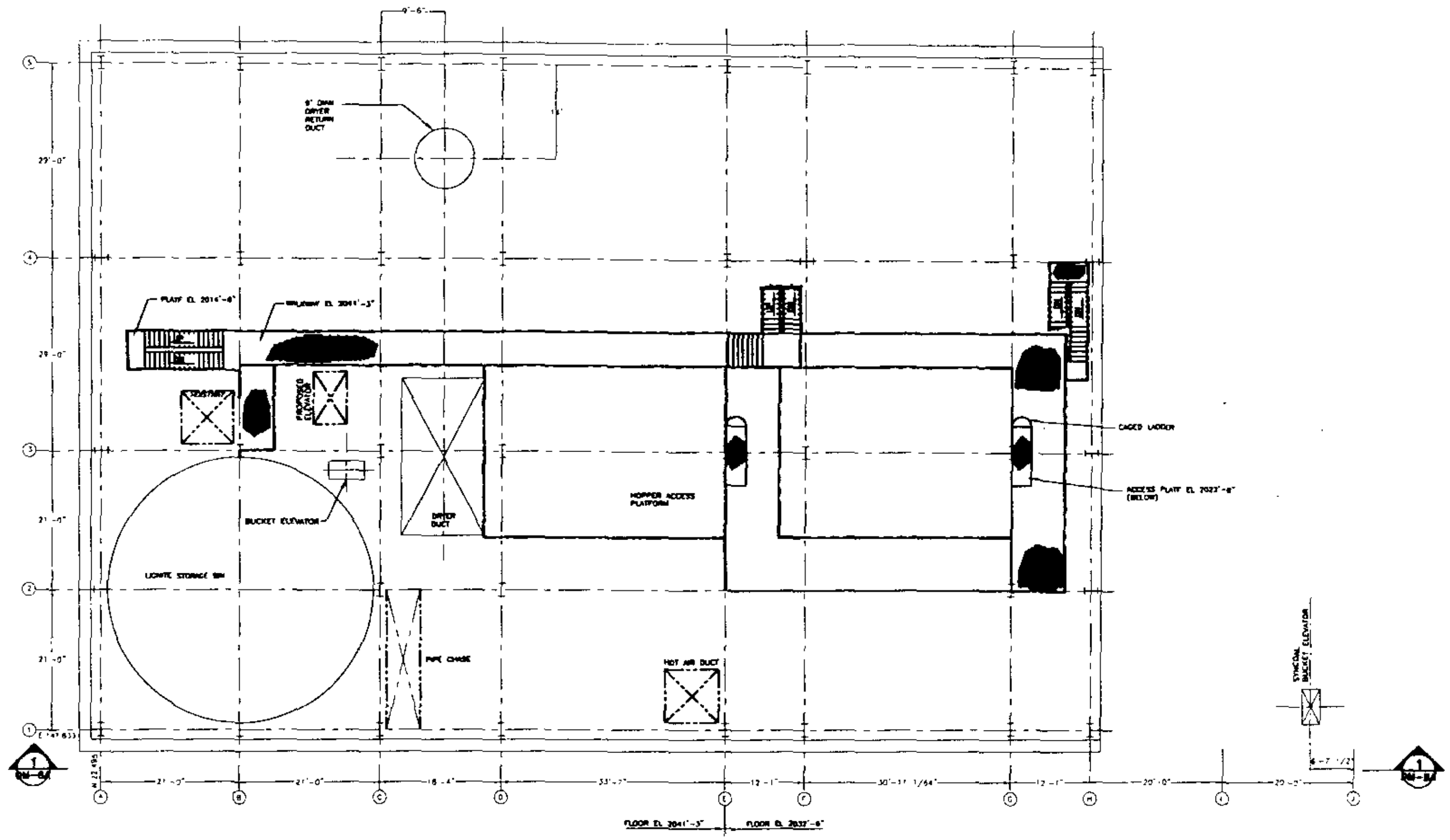
LOCATION: CENTER, NORTH DAKOTA

DWG NAME: GENERAL ARRANGEMENT - PROCESS AREA PLAN @ EL 82'-3" & 66'-8"

SCALE: AS NOTED

PROJECT NO: 97-813

DRAWING NUMBER: 97-813-076



PROCESS AREA – PLAN VIEW

SCALE: 1/8"=1'-0"

REFERENCE DRAWINGS	
2M-5A-A	GENERAL ARRANGEMENT - PROCESS AREA - PLAN @ 104'-6" & 92'-6"

CLIENT: WESTERN SYNCOAL COMPANY

PROJECT: M R YOUNG SYNCOAL PROCESS

LOCATION: CENTER, NORTH DAKOTA

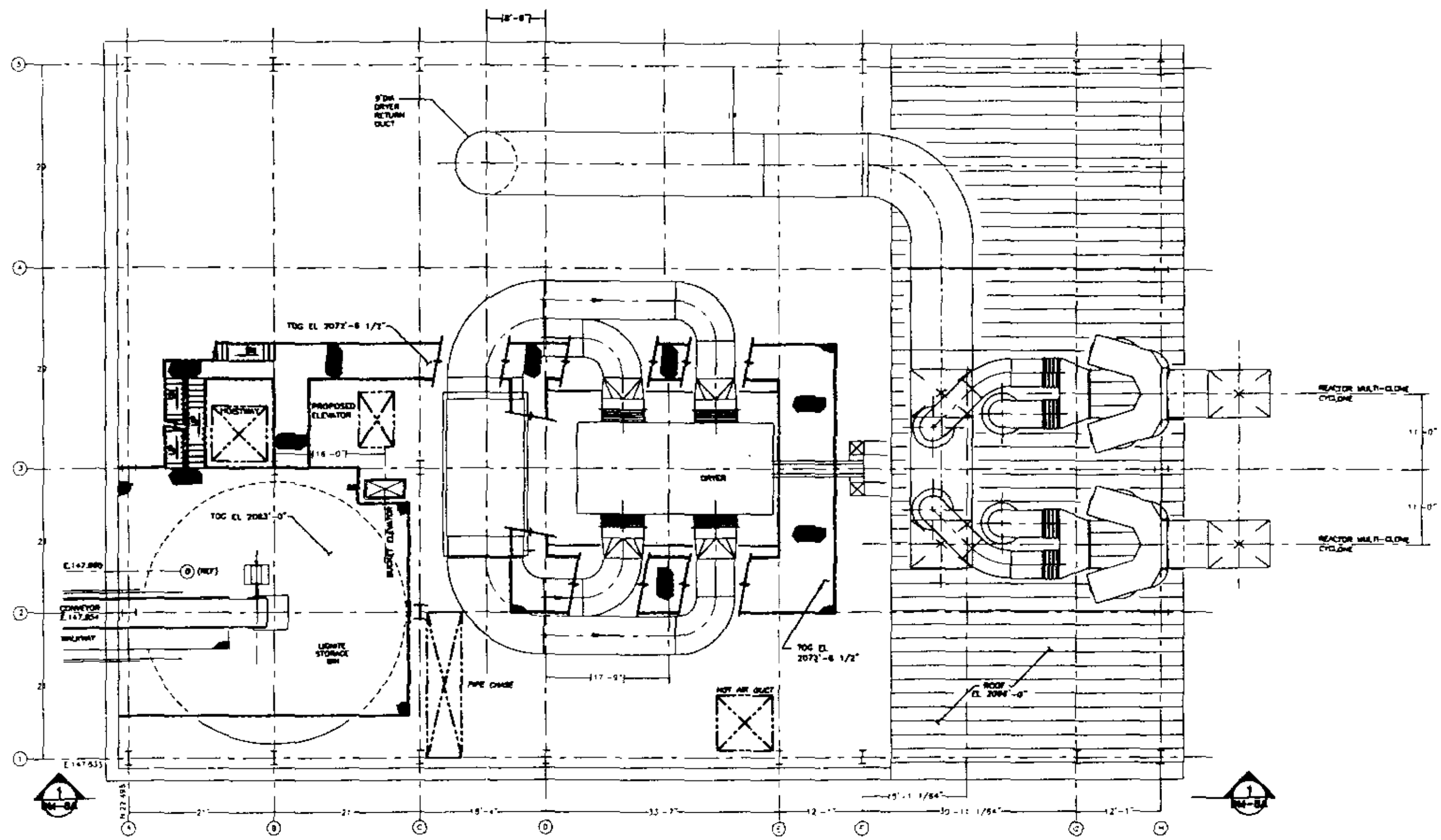
DWG NAME: GENERAL ARRANGEMENT - PROCESS AREA PLAN @ EL 104'-6" & 92'-8"

UNIFIELD

SCALE: AS NOTED

PROJECT NO: 97-813

DRAWING NUMBER: 97-813-077



PROCESS AREA – PLAN

SCALE: 1/8"=1'-0"

WESTERN SYNCOAL COMPANY

M R YOUNG SYNCOAL PROCESS

CENTER, NORTH DAKOTA

PROCESS AREA PLAN @ EL 143'-0", 132'-8" & 121'-0"

DRAWING NUMBER: 97-813-078

UNIFIELD

REFERENCE DRAWINGS: PROCESS AREA – PLAN @ EL 143'-0", 132'-8" & 121'-0"

APPENDIX B

EQUIPMENT SPECIFICATIONS

APPENDIX B-1

WOLF MATERIAL HANDLING EQUIPMENT SPECIFICATIONS

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Lot of Modifications,** to the existing Belt Conveyor 2C, including a new 75 HP, 1750 RPM, 3/60, 230/460 V, TEXP motor, fluid sheave assembly, sheaves, V-belts, guard and required mild steel support legs to increase discharge height by approximately 6'-0". All components will be furnished with the manufacturers standard paint. The fabricated steel shall be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT. All assembly bolts, A307 are included. All items will be shipped loose for final field assembly to the existing Conveyor. All Assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 3,480 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Primary Coal Diverter Valve (Item No. 6901),** two-way design, electrically operated type, for location at the discharge of the existing Conveyor 2C, to allow lignite coal to be diverted to the existing Conveyor 2A or the new Primary Infeed Belt Conveyor. The Diverter shall have the following specifications:

Slope - 60° minimum.

Construction - Housing fabricated from 1/4" thick mild steel plate with 1/4" thick mild steel flop gate, with 1/4"/1/8" thick Triten T200X plate liners on gate and at all sliding/impact wear surfaces. Liners bolted/welded in place.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearings with taconite seals and end caps.

Gate Actuator - Electric type, TEXP, motor operated liner actuator, with position switches.

Position Indicators - At actuator and two (2) back-up NEMA 9 limit switches.

Chutes - Two (2) required, fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners at all sliding/impact wear surfaces. Liners bolted/welded in place.

Assembly Bolts - Included, A307.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The Diverter Valve is assembled. The chutes are shipped separate.

ESTIMATED WEIGHT - 12,500 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Primary Infeed Belt Conveyor (Item No. CN-5401),** 48" wide x 280'-0" centers, 35° troughed design, horizontal configuration, capable of receiving, weighing and transferring lignite coal, from the Primary Coal Diverter Valve located at the discharge of the existing Conveyor 2C to the new 1,800 ton Coal Infeed Surge Bin (Bin by others), at the rate of 1,000 TPH (1,250 TPH design), based on a bulk density of 45-50 PCF and a nominal 2" material size. The Conveyor shall have the following specifications:

Drive - 60 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted helical gear reducer assembly, having a Class II service factor, via a V-belt drive assembly, to yield the required belt speed. The drive is complete with a V-belt drive, fluid sheave, OSHA style guard, adjustable motor mount and torque arm assembly.

Belt Speed - 480 FPM.

V-Belt Guard - OSHA style, complete with mounting brackets.

V-Belt Tensioner - Adjustable motor base on the reducer.

Backstop - Not required.

Drive Mount - At the conveyor head shaft.

Fluid Sheave - Non-delay fill type, for overload protection.

Belt - 48" wide, 3-ply, 330 PIW, with 3/16" x 1/16" RMA Grade II covers.

Splice - Field installed, vulcanized type (by others).

Carrying Idlers - CEMA "D", 6" diameter, 35° equal length roll troughing idlers with sealed roller bearings. The idlers shall be mounted on 4'-0" centers except at the skirtboards, where they shall be mounted on 2'-0" centers. One (1) 20° transition idler shall be provided just before the head pulley and just after the tail pulley.

Impact Idlers - CEMA "D", 6" diameter, 35° equal length roll, rubber disc type, troughing idlers with sealed roller bearings. The idlers shall be mounted on 1'-0" centers at the load area.

Carrying Training Idlers - CEMA "D", 6" diameter, 35° equal length roll troughing training idlers with sealed roller bearings. The idlers shall be mounted on 100'-0" (maximum) centers.

Return Idlers - CEMA "D", 6" diameter, flat roll idlers with sealed roller bearings. The idlers shall be mounted on 10'-0" centers.

Return Training Idlers - CEMA "D", 6" diameter, flat roll training idlers, with sealed roller bearings. The idlers shall be mounted on 100'-0" (maximum) centers.

Head Pulley - 24" diameter x 54" face, positive crowned, welded steel conveyor pulley with "XT" hubs for 4 7/16" diameter shaft and 1/2" thick herringbone grooved lagging.

Tail and Take-Up Pulleys - 20" diameter x 54" face, positive crowned, wing type, welded steel conveyor pulley with "XT" hubs for 3 15/16" diameter shaft.

Bend Pulleys - 18" diameter x 54" flat face, welded steel conveyor pulley with "XT" hubs for 3 7/16" diameter shaft and 1/2" thick plain lagging.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearing pillow blocks with taconite seals, end caps, shims and adjustable base plates. One (1) fixed and one (1) floating per shaft.

Plugged Chute Switch - For location in the discharge chute, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the tail shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Safety Stop Switches - For location along one (1) both sides of the Conveyor, NEMA 9, cable operated, manual reset type, with required cable, support eyes and mounting hardware.

Belt Alignment Switches - NEMA 9, with mounting hardware. Two (2) sets included.

Belt Cleaners - Martin Engineering, Durt Tracker primary type with urethane blades and secondary type with segmented tungsten carbide blades, each complete with twist tensioners and inspection doors. All for location at the head pulley.

Take-Up - Vertical gravity type, complete with pulleys, bearing, shafting, frame, carriage, counterweight box, bend pulley guards and counterweight guard. The take-up will have a ladder/cage from the take-up service platform up to the walkway along the side of the Conveyor.

Conveyor Covers - 20 gauge, galvanized, full type, corrugated weather covers, hinged one side, with support bands and full length wind skirts on both sides of the Conveyor truss.

Head Section - Included, channel frame construction.

Tail Section - Included, channel frame construction.

Deck Plate - No. 10 gauge mild steel, for location at the load area under the skirting and prior to the head section.

Inlet - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners and external stiffening as required. The inlet is to be designed as an integral part of the skirtboards.

Skirtboards - 12'- 0" long, including the inlet, fabricated from 1/4" thick mild steel plate with continuous 1/2" thick adjustable rubber seals at the belt surface, 10 gauge mild steel covers, supports to the conveyor frame and flanged dust pick-up connection.

Discharge Hood - Fabricated from No. 10 gauge mild steel plate with inspection door, flanged discharge and flanged dust pick-up connection. The hood shall be split at the centerline of the head shaft.

Discharge Chute - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Nip Guards - Expanded metal type at the tail pulley and bend pulleys.

Dust Curtains - Included, at both the exit from the skirtboards and the entrance to the discharge hood.

Conveyor Truss Frame - 6'-0" deep x 5'-0" wide, designed for a 100' maximum span, complete with 30" walkway along one side of the Conveyor.

Walkway - 30" wide, located along one side of the Conveyor, for that portion of the Conveyor that is outdoors, complete with handrail, toeboard, supports and galvanized bar grating.

Supports - A-frame type, fabricated from mild steel structural shapes and plates, for support of the truss from grade/building. Four (4) required.

Belt Scale - Four idler design, complete with the following major components:

Scale:

- Weighing platform constructed of 1/4" rectangular steel structural members supporting four weighing idlers.
- Four (4) check rods preventing lateral and horizontal movement, providing a stable platform for accurate weighing.
- Two (2) weather-proof enclosures on each end of the weighing platform that serve as load cell bridges.
- Four (4) precision strain gauge load cells with overload protection, supporting the weighing platform. Five feet of flexible connecting conduit is included.
- Four (4) weigh idlers.

Integrator:

- Microprocessor based integrator with count rates to 200,000 counts per hour.
- Four (4) line x twenty (20) character alpha-numeric display indicating total weight, flow-rate and selectable belt speed or belt loading.
- Simple keyboard entry of all calibration data with menu-driven prompting from the display.
- Auto zero actuated by a simple keystroke (or remote pushbutton) to tare the scale.
- Auto span actuated by a simple keystroke to calibrate the scale.
- Auto zero tracking can be enabled via the front keypad an allows fully automatic zero at a selectable flow rate up to 10%.
- Solid state pulse output gives one pulse per each increase of the lease significant digit of total.
- Alarm contact outputs for load, speed or rate and system failure.
- Full diagnostics to confirm proper operation of the scale system.
- Five (5) expansion slots for optional analog or communications requirements.
- NEMA 4X enclosure or DIN 43700 panel mount.
- Power required 110/120/220/240 VAC, (switch selectable) 50-60 Hz, 25 VA.
- Includes provisions to electronically simulate a loaded belt.
- Includes one (1) 4-20 mA analog output board.

Load Cell Digitizer:

- Provides load cell excitation and converts the load cell output signal to digitized output signal for use in the integrator.
- NEMA 9 enclosure.
- Requires 110/120/220/240 VAC (switch selectable) 50-60 Hz.

Belt Speed Sensor:

- Digital, brushless
- NEMA 9 enclosure

Static Calibration Weights:

- Set of static calibration weights to simulate approximately 50% of full scale, belt loading. Also included is a mechanical weight-lifting device (manually operated) for storage an impingement of static calibration weights.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The head section, tail section and gravity take-up shall be shop assembled. The drive shall be shop assembled and mounted. The truss frame shall ship assembled in 40' lengths. The truss frame will be assembled with the skirtboards and troughing idlers mounted. The return idler rolls will ship loose, with the return idler mounting brackets mounted. The walkway will ship separate in sections. The conveyor belt shall be shipped separate. The A-frame supports shall ship separate and in sections/pieces. The take-up guard, counterweight box and cables will ship separate. The take-up service platform and access ladder/cage will ship separate. The belt scale controls shall be shipped separate. The belt scale will be mounted to the conveyor truss frame. The discharge chute shall be shipped separate. All conveyor switches will ship loose. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 284,150 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Process Infeed Weigh Belt Feeder (Item No. CN-5405),** 48" wide x 15'-0" centers, flat belt design, horizontal configuration, capable of receiving, weighing and transferring lignite coal, from the Bin discharge at the 1,800 ton Coal Infeed Surge Bin (Bin by others) to the Process Infeed Belt Conveyor, which feeds the Crushers, at a rate of 137 TPH (design), based on a bulk density of 45-50 PCF and a nominal 2" material size. The Feeder shall have the following specifications:

Drive - Variable speed type, 7.5 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted gear reducer assembly, having a Class II service factor, to yield the required belt speed.

Belt Speed - Variable, 80 FPM at design rate.

Backstop - Not required.

Drive Mount - At the conveyor head shaft.

Variable Speed Drive - AC variable frequency type.

Belt - 48" wide, 2-ply, with 1/8" x 1/16" RMA Grade II covers and 80 mm corrugated edge.

Splice - Shop installed, vulcanized type.

Carrying Idlers - CEMA "C", 4" diameter, flat carrying idlers with sealed roller bearings. The idlers shall be mounted on the required centers.

Return Idlers - CEMA "C", 4" diameter, flat roll idlers with sealed roller bearings. The idlers shall be mounted on the required centers.

Head Pulley - 12" diameter x 51" face, positive crowned, welded steel conveyor pulley with hubs for 2 15/16" diameter shaft and rubber lagging.

Tail Pulley - 12" diameter x 51" face, positive crowned, welded steel conveyor pulley with hubs for 2 7/16" diameter shaft.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, pillow blocks.

Plugged Chute Switch - For location in the discharge chute, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - See belt speed sensor with belt scale.

Safety Stop Switch - Not required, enclosed construction.

Belt Cleaners - Counterweighted type, with UHMWP blades.

Take-Up - Screw type, complete with bearing as previously described and 12" of travel.

Frame - I-Beam design, fabricated from mild steel structural shapes and plates with required spreaders.

Supports - Channel type.

Covers - Full top dust covers with access doors and full bottom covers. Mild steel construction.

Inlet - Flanged, with (manually) adjustable profile gate fabricated from mild steel.

Skirtboards - Full length, including the inlet, fabricated from mild steel with continuous rubber seals at the belt surface.

Discharge Hood - Part of the covers.

Discharge Chute - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Walkway - 30" wide, located along one side of the Feeder, complete with two-rail handrail, toeboard, galvanized bar grating and access stairways.

Belt Scale - Single idler design, complete with the following major components:

Scale:
- Pivotless full-floating platform scale design.
- Precision, hermetically sealed, shear beam strain gauge load cell.
- NEMA 9 scale junction box.

Integrator:

- Microprocessor based integrator with count rates to 200,000 counts per hour.
- Four (4) line x twenty (20) character alpha-numeric display indicating total weight, flow-rate and selectable belt speed or belt loading.
- Simple keyboard entry of all calibration data with menu-driven prompting from the display.
- Auto zero actuated by a simple keystroke (or remote pushbutton) to tare the scale.
- Auto span actuated by a simple keystroke to calibrate the scale.
- Auto zero tracking can be enabled via the front keypad an allows fully automatic zero at a selectable flow rate up to 10%.
- Solid state pulse output gives one pulse per each increase of the lease significant digit of total.
- Alarm contact outputs for load, speed or rate and system failure.
- Full diagnostics to confirm proper operation of the scale system.
- Two (2) expansion slots for optional analog or communications requirements.
- NEMA 4X enclosure or DIN 43700 panel mount.
- Power required 110/120/220/240 VAC, (switch selectable) 50-60 Hz, 25 VA.
- Includes provisions to electronically simulate a loaded belt.

Belt Speed Sensor:

- Digital, brushless
- NEMA 9 enclosure

Assembly Bolts - Included.

Surface Preparation - Manufacturers standard on the Feeder. SSPC-SP6 commercial grade blast cleaning on the walkway and discharge chute fabricated steel.

Finish - Manufacturers standard on the Feeder. One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT on the walkway and discharge chute fabricated steel.

Assembly - The Feeder shall be completely shop assembled and shipped as a unit. The belt scale controls shall ship separate. The discharge chute shall ship separate. The plugged chute switch will ship loose. The walkway and supports will ship loose. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 9,870 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Process Infeed Belt Conveyor,** 24" wide x 60'-0" centers, inclined configuration, capable of receiving and transferring lignite coal, from the Process Infeed Weigh Belt Feeder to either of the Crushers via the (Process Infeed) Coal Diverter Valve, at a rate of 137 TPH (design), based on a bulk density of 45-50 PCF and a nominal 2" material size. The Conveyor shall have the following specifications:

Drive - 10 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted helical gear reducer assembly, having a Class II service factor, via a V-belt drive assembly, to yield the required belt speed. The drive is complete with a V-belt drive, OSHA style guard, adjustable motor mount and torque arm assembly.

Belt Speed - 235 FPM.

V-Belt Guard - OSHA style, complete with mounting brackets.

V-Belt Tensioner - Adjustable motor base on the reducer.

Backstop - Internal type, integral with the reducer.

Drive Mount - At the conveyor head shaft.

Fluid Sheave - Not included.

Belt - 24" wide, 2-ply, 220 PIW, with 3/16" x 1/16" RMA Grade II covers.

Splice - Field installed, vulcanized type (by others).

Carrying Idlers - CEMA "D", 6" diameter, 35° equal length roll troughing idlers with sealed roller bearings. The idlers shall be mounted on 2'-0" centers. One (1) 20° transition idler shall be provided just before the head pulley and just after the tail pulley.

Impact Idlers - CEMA "D", 6" diameter, 35° equal length roll, rubber disc type, troughing idlers with sealed roller bearings. The idlers shall be mounted on 1'-0" centers at the load area.

Carrying Training Idlers - Not required.

Return Idlers - CEMA "D", 6" diameter, flat roll idlers with sealed roller bearings. The idlers shall be mounted on 10'-0" centers.

Return Training Idlers - Not required.

Head Pulley - 18" diameter x 28" face, positive crowned, welded steel conveyor pulley with "XT" hubs for 2 15/16" diameter shaft and 1/2" thick herringbone grooved lagging.

Tail Pulley - 16" diameter x 28" face, positive crowned, wing type, welded steel conveyor pulley with "XT" hubs for 2 7/16" diameter shaft.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearing pillow blocks with taconite seals, end caps, shims and adjustable base plates. One (1) fixed and one (1) floating per shaft.

Plugged Chute Switch - For location in the Discharge Chute, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the tail shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Safety Stop Switches - For location along both sides of the Conveyor, NEMA 9, cable operated, manual reset type, with required cable, support eyes and mounting hardware.

Belt Alignment Switches - NEMA 9, with mounting hardware. Two (2) sets included.

Belt Cleaners - Martin Engineering, Durt Tracker primary type with urethane blades and secondary type with segmented tungsten carbide blades, each complete with twist tensioners and inspection doors. All for location at the head pulley.

Take-Up - Screw type, complete with bearing as previously described and 18" of travel.

Conveyor Frame - Channel design, fabricated from mild steel structural shapes and plates with required spreaders.

Head Section - Included, channel frame construction.

Tail Section - Included, channel frame construction.

Deck Plate - No. 12 gauge mild steel, for location along the full length of the Conveyor.

Supports - Leg-type, fabricated from mild steel structural shapes and plates, for support of the Conveyor from grade and Crusher Support/Access Platform Structure.

Inlet - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners and external stiffening as required. The inlet is to be designed as an integral part of the skirtboards.

Skirtboards - 55'- 0" long, including the inlet, fabricated from 1/4" thick mild steel plate with continuous 1/2" thick adjustable rubber seals at the belt surface, No. 12 gauge mild steel covers, supports to the conveyor frame and flanged dust pick-up connection. Skirtboards are provided for the full length of the Conveyor for dust tight operation.

Discharge Hood - Fabricated from No. 10 gauge mild steel plate with inspection door, flanged discharge and flanged dust pick-up connection. The hood shall be split at the centerline of the head shaft.

Discharge Chute - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Nip Guard - Expanded metal type at the tail pulley.

Dust Curtains - Not required. The Conveyor is skirted full length.

Walkway - 30" wide, located along one side of the Conveyor, for that portion of the Conveyor that is not accessible from grade, complete with two-rail handrail, toeboard, galvanized bar grating and access stairway.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The head section and tail section shall be shop assembled. The drive shall be shop assembled and mounted. The conveyor frame will be assembled in approximately 20'-0" lengths with the skirtboards and troughing idlers mounted. The return idler rolls will ship loose, with the return idler mounting brackets mounted. The conveyor belt shall be shipped separate. The supports will be mounted if possible.All other supports shall ship separate. The discharge chute shall be shipped separate. The walkway will ship loose. All conveyor switches will ship loose. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 21,970 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Permanent Magnet,** for location over the Process Infeed Belt Conveyor, for removal of tramp (ferrous) metal from the lignite coal flow. The Magnet shall have the following specifications:

- For removal of 1" cube or greater
- Inline mounting arrangement
- 12" Suspension height
- Manually cleaned, with swing arm stripper
- 30" wide x 39" long x 15" high
- Full width magnetic field
- Magnet, poles and sides are heavy carbon steel construction
- Heavy manganese bottom plate
- Adjustable suspension sling
- Trolley, manual
- Support steel
- The Magnet, sling and trolley will have the manufacturer's standard paint system. The support steel will be painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

ESTIMATED MAGNET WEIGHT - 3,400 lbs.

Wolf and Associates, Inc.
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- TECHNICAL SPECIFICATIONS -

1 - **(Process Infeed) Coal Diverter Valve (Item No. DV-6904),** two-way design, air cylinder operated type, for location at the discharge of the Process Infeed Belt Conveyor to allow lignite coal to be diverted to either of the two (2) Crushers. The Diverter shall have the following specifications:

Slope - 60° minimum.

Construction - Housing fabricated from 1/4" thick mild steel plate with 1/4" thick mild steel flop gate, with 1/4"/1/8" thick Triten T200X plate liners on gate and at all sliding/impact wear surfaces. Liners bolted/welded in place.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearings with taconite seals and end caps.

Gate Actuator - Pneumatic type, air cylinder, with explosion proof solenoid valve.

Position Indicators - Two (2) NEMA 9, limit switch type.

Chutes - Two (2) required, fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners at all sliding/impact wear surfaces. Liners bolted/welded in place.

Assembly Bolts - Included, A307.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The diverter valve is assembled. The chutes are shipped separate.

ESTIMATED WEIGHT - 7,000 lbs.

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(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

2 - **Coal Infeed Crushers (Item Nos. CG-1801 and CG-1802),** two roll, single stage type, each capable of reducing a nominal 2" lignite coal to 95% passing minus 3/4", at a rate of 137 TPH (design). Each Crusher shall have the following specifications:

- Single motor drive arrangement, with 25 HP, 1200 RPM, 3/60, 460 V, 1.15 S.F. TEXP motor and gear box for timed rolls.
- Operating speed 300 RPM.
- Primary V-belt type drive.
- V-belt guard.
- Fabricated steel base frame incorporating machined bearing pads with pre-drilled discharge connections.
- Dribble chutes to redirect any product spillage from the housing shaft openings, back into the discharge area.
- Slot closures for sealing housing shaft openings.
- 2 15/16" cartridge bearings.
- Four-piece housing with maintenance doors.
- Dual bulkhead lubrication system. Hydraulic hoses bring all lubrication points up to two bulkheads for easy access.
- Rolls with 11 continuous tooth design, non-hardfaced.
- Coupling mounted rolls for change-out without disturbing the bearings, V-belt drives, guards or motors.
- Manual adjustment of rolls by means of Acme Screw. The mechanism allows rolls to be adjusted while unit is in operation.
- Spring type tramp iron relief.
- Discharge chute, converging design, for use with both Crushers, allowing either unit to discharge to the Crusher Discharge Belt Conveyor. Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.
- Assembly bolts included.
- The Crushers will have the manufacturer's standard paint. The discharge chute will be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.
- The Crusher is shipped assembled. The motor, v-belt drive and guard are shipped separate. The discharge chute is shipped in sections. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED CRUSHER WEIGHT - 5,650 lbs. Each
- 5,910 lbs. (chute)

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- TECHNICAL SPECIFICATIONS -

1 - **Crusher Support/Access Platform,** 20' x 20' in plan x 22' high, for support and access to both of the Coal Infeed Crushers. The Support/Access Platform is complete with stairways, two-rail handrailing, galvanized bar grating and toeboards. The Platform steel shall be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT. The Platform shall be shipped in pieces/sections for final field assembly. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 45,370 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **Crusher Discharge Belt Conveyor (Item No. CN-5406),** 24" wide x 42'-0" centers, inclined configuration, capable of receiving and transferring lignite coal, from the Crushers via the (Process Infeed) Bucket Elevator, at a rate of 137 TPH (design), based on a bulk density of 45-50 PCF and a 3/4" minus material size. The Conveyor shall have the following specifications:

Drive - 10 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted helical gear reducer assembly, having a Class II service factor, via a V-belt drive assembly, to yield the required belt speed. The drive is complete with a V-belt drive, OSHA style guard, adjustable motor mount and torque arm assembly.

Belt Speed - 235 FPM.

V-Belt Guard - OSHA style, complete with mounting brackets.

V-Belt Tensioner - Adjustable motor base on the reducer.

Backstop - Internal type, integral with the reducer.

Drive Mount - At the conveyor head shaft.

Fluid Sheave - Not required.

Belt - 24" wide, 2-ply, 220 PIW, with 3/16" x 1/16" RMA Grade II covers.

Splice - Field installed, vulcanized type (by others).

Carrying Idlers - CEMA "D", 6" diameter, 35° equal length roll troughing idlers with sealed roller bearings. The idlers shall be mounted on 2'-0" centers. One (1) 20° transition idler shall be provided just before the head pulley and just after the tail pulley.

Impact Idlers - CEMA "D", 6" diameter, 35° equal length roll, rubber disc type, troughing idlers with sealed roller bearings. The idlers shall be mounted on 1'-0" centers at the load area.

Carrying Training Idlers - Not required.

Return Idlers - CEMA "D", 6" diameter, flat roll idlers with sealed roller bearings. The idlers shall be mounted on 10'-0" centers.

Return Training Idlers - Not required.

Head Pulley - 18" diameter x 28" face, positive crowned, welded steel conveyor pulley with "XT" hubs for 2 15/16" diameter shaft and 1/2" thick herringbone grooved lagging.

Tail Pulley - 16" diameter x 28" face, positive crowned, wing type, welded steel conveyor pulley with "XT" hubs for 2 7/16" diameter shaft.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearing pillow blocks with taconite seals, end caps, shims and adjustable base plates. One (1) fixed and one (1) floating per shaft.

Plugged Chute Switch - For location in the discharge chute, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the tail shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Safety Stop Switches - For location along both sides of the Conveyor, NEMA 9, cable operated, manual reset type, with required cable, support eyes and mounting hardware.

Belt Alignment Switches - NEMA 9, with mounting hardware. Two (2) sets included.

Belt Cleaners - Martin Engineering, Durt Tracker primary type with urethane blades and secondary type with segmented tungsten carbide blades, each complete with twist tensioners and inspection doors. All for location at the head pulley.

Take-Up - Screw type, complete with bearing as previously described and 18" of travel.

Conveyor Frame - Channel design, fabricated from mild steel structural shapes and plates with required spreaders.

Head Section - Included, channel frame construction.

Tail Section - Included, channel frame construction.

Deck Plate - No. 12 gauge mild steel, for location along the full length of the Conveyor.

Supports - Leg-type, fabricated from mild steel structural shapes and plates, for support of the Conveyor from grade.

Inlet - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners and external stiffening as required. The inlet is to be designed as an integral part of the skirtboards.

Skirtboards - 37'- 0" long, including the inlet, fabricated from 1/4" thick mild steel plate with continuous 1/2" thick adjustable rubber seals at the belt surface, No. 12 gauge mild steel covers, supports to the conveyor frame and flanged dust pick-up connection. Skirtboards are provided for the full length of the Conveyor for dust tight operation.

Discharge Hood - Fabricated from No. 10 gauge mild steel plate with inspection door, flanged discharge and flanged dust pick-up connection. The hood shall be split at the centerline of the head shaft.

Discharge Chute - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Nip Guard - Expanded metal type at the tail pulley.

Dust Curtains - Not required. The Conveyor is skirted full length.

Walkway - 30" wide, located along one side of the Conveyor, for that portion of the Conveyor that is not accessible from grade, complete with two-rail handrail, toeboard, galvanized bar grating and access stairway.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The head section and tail section shall be shop assembled. The drive shall be shop assembled and mounted. The conveyor frame will be assembled in approximately 20'-0" lengths with the skirtboards and troughing idlers mounted. The return idler rolls will ship loose, with the return idler mounting brackets mounted.

The conveyor belt shall be shipped separate. The supports will be mounted if possible. All other supports shall ship separate. The discharge chute shall be shipped separate. The walkway will ship loose. All conveyor switches will ship loose. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 16,090 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **(Process Infeed) Bucket Elevator (Item No. BE-5301),** 16" x 13 1/8" x 18" cup x 150'-0" discharge height, double chain type, continuous discharge design, capable of receiving and elevating 137 TPH (design) of lignite coal, based on a bulk density of 45-50 PCF and a 3/4" minus material size, from the Crusher Discharge Belt Conveyor to the Dryer Infeed Double Dump Valve (Valve by others). The Bucket Elevator shall have the following specifications:

Drive - 50 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted helical gear reducer assembly, having a Class II service factor, via a V-belt drive assembly, to yield the required chain speed. The drive is complete with a V-belt drive, OSHA style guard, adjustable motor mount and backstop.

Chain Speed - 135 FPM.

V-Belt Tensioner - Adjustable base at the motor.

V-Belt Guard - OSHA style, complete with mounting brackets.

Backstop - Integral with the reducer.

Carrying Chain - Double strand, hardened steel bushed rollerless elevator type, No. X 4004-G5, 9" pitch with G5 attachments every other pitch for mounting cups.

Cups - 16" x 13 1/8" x 18", HL style elevator cups, fabricated from No. 7 gauge mild steel, mounted on 18" centers.

Head Bearings - Anti-friction, self-aligning, roller bearing pillow blocks with taconite seals, end caps, shims and adjustable base plates. One (1) fixed and one (1) floating per shaft. 5 7/16" diameter.

Take-Up - Gravity type, with 12" of travel, complete with 2 15/16" diameter Ni-hard bearings.

Shafting - C-1045, cold rolled steel, turned and ground. The head shaft is 6 1/2" diameter. The boot shaft is 2 15/16" diameter.

Head Sprockets - 10 tooth, 29.12" P.D., solid hub, chilled rim type, fabricated from a chill iron cast material, induction case-hardened and bored and keyed as required.

Tail Wheels - 26" diameter, solid hub, chilled rim, segmented type, bored and keyed as required.

Intermediate Casing - Single stand design, 34" x 64", fabricated from No. 10 gauge mild steel plate complete with flanges and inspection door on first casing section above the boot section. Casing is fabricated with heavy duty corner angles, chain guides and external stiffeners.

Head Section - Fabricated from 1/4" thick mild steel plate and structural shapes, complete with No. 12 gauge mild steel two-piece hood, inspection door and a flanged discharge.

Boot Section - Fabricated from 1/4" thick mild steel plate complete with clean-out doors on the front and back, hinged access doors on each side, take-up hoist beam, 3/8" thick mild steel bottom plate and flanged inlet.

Inlet - Fabricated from 1/4" thick mild steel plate, with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Discharge - Fabricated from 1/4" thick mild steel plate, with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Discharge Chute - To Dryer Infeed Double Dump Valve No. DD-7001 (Valve by others), fabricated from 1/4" thick mild steel plate, complete with flanges and 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Dust Collection Nozzle - One (1) provided for location at the head section, flanged, fabricated from No. 10 gauge mild steel.

Sway Bracing - Fabricated from mild steel shapes and plates for lateral bracing to building steel (by others) on approximately 20'-0" centers.

Plugged Chute Switch - For location at the discharge, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the boot shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Access Platform - Not included. See Options.

Ladder/Cage/Rest Platforms - Not included. See Options.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The head section and drive shall be shop assembled. The boot section shall be shop assembled. The casing shall be assembled in 10'-0" lengths. The cups and chain will be shipped loose. The zero speed switch and the plugged chute switch shall ship loose. The sway bracing and discharge chute shall ship separate. All assembly bolts shall be boxed and tagged. All items shipped unassembled shall be match-marked and/or identified.

ESTIMATED WEIGHT - 87,900 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **Coolers Discharge Belt Conveyor (Item No. CN-5411),** 24" wide x 90'-0" centers, inclined configuration, capable of receiving and transferring SynCoal, from the Double Dump Valves (Valves by others) at the Coolers (Coolers by others) to the SynCoal Product Screen at a rate of 67 TPH (design), based on a bulk density of 38-42 PCF and a nominal 1/4" material size. The Conveyor shall have the following specifications:

Drive - 10 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted helical gear reducer assembly, having a Class II service factor, via a V-belt drive assembly, to yield the required belt speed. The drive is complete with a V-belt drive, fluid sheave, OSHA style guard, adjustable motor mount and torque arm assembly.

Belt Speed - 150 FPM.

V-Belt Guard - OSHA style, complete with mounting brackets.

V-Belt Tensioner - Adjustable motor base on the reducer.

Backstop - Internal type, integral with the reducer.

Drive Mount - At the conveyor head shaft.

Fluid Sheave - Non-delay fill type, for overload protection.

Belt - 24" wide, 2-ply, 220 PIW, with 3/16" x 1/16" RMA Grade II covers.

Splice - Field installed, vulcanized type (by others).

Carrying Idlers - CEMA "D", 6" diameter, 35° equal length roll troughing idlers with sealed roller bearings. The idlers shall be mounted on 2'-0" centers. One (1) 20° transition idler shall be provided just before the head pulley and just after the tail pulley.

Impact Idlers - CEMA "D", 6" diameter, 35° equal length roll, rubber disc type, troughing idlers with sealed roller bearings. The idlers shall be mounted on 1'-0" centers at the load area.

Carrying Training Idlers - Not required.

Return Idlers - CEMA "D", 6" diameter, flat roll idlers with sealed roller bearings. The idlers shall be mounted on 10'-0" centers.

Return Training Idlers - Not required.

Head Pulley - 18" diameter x 28" face, positive crowned, welded steel conveyor pulley with "XT" hubs for 2 15/16" diameter shaft and 1/2" thick herringbone grooved lagging.

Tail Pulley - 16" diameter x 28" face, positive crowned, wing type, welded steel conveyor pulley with "XT" hubs for 2 7/16" diameter shaft.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearing pillow blocks with taconite seals, end caps, shims and adjustable base plates. One (1) fixed and one (1) floating per shaft.

Plugged Chute Switch - For location in the discharge chute, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the tail shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Safety Stop Switches - For location along both sides of the Conveyor, NEMA 9, cable operated, manual reset type, with required cable, support eyes and mounting hardware.

Belt Alignment Switches - NEMA 9, with mounting hardware. Two (2) sets included.

Belt Cleaners - Martin Engineering, Durt Tracker primary type with urethane blades and secondary type with segmented tungsten carbide blades, each complete with twist tensioners and inspection doors. All for location at the head pulley.

Take-Up - Screw type, complete with bearing as previously described and 30" of travel.

Conveyor Frame - Channel design, fabricated from mild steel structural shapes and plates with required spreaders.

Head Section - Included, channel frame construction.

Tail Section - Included, channel frame construction.

Deck Plate - No. 12 gauge mild steel, for location along the full length of the Conveyor.

Supports - Leg-type, fabricated from mild steel structural shapes and plates, for support of the Conveyor from grade and Screen/Crusher Support/Access Platform structure.

Inlets - Two (2) fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners and external stiffening as required. The inlet is to be designed as an integral part of the skirtboards.

Skirtboards - 85'-0" long, including the inlet, fabricated from 1/4" thick mild steel plate with continuous 1/2" thick adjustable rubber seals at the belt surface, No. 12 gauge mild steel covers, supports to the conveyor frame and flanged dust pick-up connection. Skirtboards are provided for the full length of the Conveyor for dust tight operation.

Discharge Hood - Fabricated from No. 10 gauge mild steel plate with inspection door, flanged discharge and flanged dust pick-up connection. The hood shall be split at the centerline of the head shaft.

Discharge Chute - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Nip Guard - Expanded metal type at the tail pulley.

Dust Curtains - Not required. The Conveyor is skirted full length.

Walkway - 30" wide, located along one side of the Conveyor, for that portion of the Conveyor that is not accessible from grade, complete with two-rail handrail, toeboard, galvanized bar grating and access stairway.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The head section and tail section shall be shop assembled. The drive shall be shop assembled and mounted. The conveyor frame will be assembled in approximately 20'-0" lengths with the skirtboards and troughing idlers mounted. The return idler rolls will ship loose, with the return idler mounting brackets mounted. The conveyor belt shall be shipped separate. The supports will be mounted if possible. All other supports shall ship separate. The discharge chute shall be shipped separate.
The walkway will ship loose. All conveyor switches will ship loose. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 34,980 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **Permanent Magnet,** for location over the Coolers Discharge Belt Conveyor, for removal of tramp (ferrous) metal from the SynCoal flow. The Magnet shall have the following specifications:

- For removal of 1" cube or greater
- Inline mounting arrangement
- 12" Suspension height
- Manually cleaned, with swing arm stripper
- 30" wide x 39" long x 15" high
- Full width magnetic field
- Magnet, poles and sides are heavy carbon steel construction
- Heavy manganese bottom plate
- Adjustable suspension sling
- Trolley, manual
- Support steel
- The Magnet, sling and trolley will have the manufacturer's standard paint system. The support steel will be painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

ESTIMATED MAGNET WEIGHT - 3,400 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **SynCoal Product Screen (Item No. SN-2203),** single deck type, vibrating design, 4'-0" x 10'-0", capable of receiving 67 TPH (design) of a nominal 1/4" SynCoal material, weighing 38-42 PCF, removing the plus 1/4" product from the material stream for discharge to the SynCoal Product Crusher for size reduction, with the sized minus 1/4" product discharged to the SynCoal Primary Belt Conveyor. The Screen shall have the following specifications:

- Installed at a 20° decline.
- The screening media is 304 stainless steel woven wire screen cloth with 1/4" square opening.
- The screen box assembly is constructed of mild steel and consist of 1/4" thick side plates, flanged both top and bottom, with full depth spring brackets for one heavy-duty steel isolation springs at each corner, and a 3/8" thick reinforcing plate located at the drive providing greater distribution of the drives forces throughout the side plates. The deck assembly is attached to the side plates with huck fasteners and is a rigid one-piece fixtured weldment which assures squareness and consists of heavy structural angle side members and 3" diameter Schedule 40 pipe cross members with end caps, welded to the side members. 3/8" thick deep longitudinal bars with rubber caps support the screen media forming either a single or double crown. Heavy structural ship channels are used with hold down assemblies on double crown designs. The screening media is attached to the screen box with clamp plates and clamp bolt assemblies.
- Located at the center of gravity of the screen box mass is the unbalanced shaft drive assembly which develops a circular motion over the entire screen box, producing a consistent material travel speed and acceleration which is essential in good particle separation and high screen efficiency. This drive assembly operates at 1,040 RPM and produces 1/4" stroke. Stroke adjustments can be made by decreasing or increasing the weight segments on the external unbalance weight wheels. The large diameter concentric shaft is enclosed in a heavy wall tubular housing and operates in two (2) double cartridge mounted straight bore spherical roller bearings. The unit is driven by a 5 HP TEXP 1750 RPM 230/460-volt, 3-phase, 60-cycle NEMA Design "C" motor through a V-belt drive, complete with safety guard and a spring loaded automatic motor base.
- The bearings are manually grease lubricated with "EP" (Extreme Pressure) Lithium Base Greases. Labyrinth seals are used to protect the bearings against entry of grit and water, lube liners are externally piped to outside the counterweight guards for easy access.

- The Screen is mounted on one steel heavy-duty coil springs located at each corner which are designated to isolate a minimum of 93% of the dynamic forces from the surrounding structure.
- 3/8" Replaceable T-1A steel liners are installed in the feed hopper.
- Discharge chutes from the accepts discharge and from the overs discharge are provided, fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.
- Motor plugging control components, include timer and relay. The plugging control is to prevent possible damaging vibrations, as the unit goes through resonance during stopping. To accomplish this, the unit is de-energized and allowed to coast for a timed period, thereby permitting a large amount of energy to be dissipated. After this timed period, the unit is energized in the reverse direction for a timed period. This brings the unit through resonance quickly, thus preventing any large amplitude vibration. The unit is then de-energized again upon coming to a stop preventing starting in the reverse direction.
- Assembly bolts included.
- The Screen will have the manufacturer's standard paint. The discharge chute will be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.
- The Screen is shipped assembled. The motor, v-belt drive and guard are shipped separate. The discharge chutes are shipped separate. The plugging controls are shipped loose. All assembly bolts shall be boxed and tagged. All items shipped unassembled shall be match-marked and/or identified.

ESTIMATED WEIGHT - 5,700 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **SynCoal Product Crusher (Item No. CG-1803),** two roll, single stage type, capable of reducing a minus 3/4" to plus 1/4" SynCoal material, to a minus 1/4" product, at a rate of 7 TPH (design). The Crusher shall have the following specifications:

- Single motor drive arrangement, with 10 HP, 1200 RPM, 3/60, 460 V, 1.15 S.F. TEXP motor and gear box for timed rolls.
- Operating speed 300 RPM.
- Primary V-belt type drive.
- V-belt guard.
- Fabricated steel base frame incorporating machined bearing pads with pre-drilled discharge connections.
- Dribble chutes to redirect any product spillage from the housing shaft openings, back into the discharge area.
- Slot closures for sealing housing shaft openings.
- 2 15/16" cartridge bearings.
- Four-piece housing with maintenance doors.
- Dual bulkhead lubrication system. Hydraulic hoses bring all lubrication points up to two bulkheads for easy access.
- Rolls with diamond tooth design, non-hardfaced.
- Coupling mounted rolls for change-out without disturbing the bearings, V-belt drives, guards or motors.
- Manual adjustment of rolls by means of Acme Screw. The mechanism allows rolls to be adjusted while unit is in operation.
- Spring type tramp iron relief.
- Discharge chute, allowing the unit to discharge to the SynCoal Primary Belt Conveyor. Fabricated from 1/4" thick M.S. plate with 1/4"/1/8" Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.
- Assembly bolts included.
- The Crusher will have the manufacturer's standard paint. The discharge chute will be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.
- The Crusher is shipped assembled. The motor, V-belt drive and guard are shipped separate. The discharge chute is shipped separate. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED CRUSHER WEIGHT - 5,650 lbs.
- 3,010 lbs. (Chute)

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- TECHNICAL SPECIFICATIONS -

1 - **Screen/Crusher Support/Access Platform,** 16' x 16' in plan x 20' high, for support and access to the SynCoal Product Screen and SynCoal Product Crusher. The Support/Access Platform is complete with stairway, two-rail handrailing, galvanized bar grating and toeboards. The Platform steel shall be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT. The Platform shall be shipped in pieces/sections for final field assembly. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 31,620 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **Screen/Crusher Support/Access Platform,** 16' x 16' in plan x 20' high, for support and access to the SynCoal Product Screen and SynCoal Product Crusher. The Support/Access Platform is complete with stairway, two-rail handrailing, galvanized bar grating and toeboards. The Platform steel shall be blasted to an SSPC-SP6 and painted with one (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT. The Platform shall be shipped in pieces/sections for final field assembly. All assembly bolts shall be boxed and tagged. All items shipped loose shall be match-marked and/or identified.

ESTIMATED WEIGHT - 31,620 lbs.

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- TECHNICAL SPECIFICATIONS -

1 - **SynCoal Primary Belt Conveyor (Item No. CN-5412),** 42" wide x 70'-0" centers, inclined configuration, capable of receiving, weighing and transferring SynCoal, from the SynCoal Product Screen and the SynCoal Product Crusher to the SynCoal Bucket Elevator, at the rate of 67 TPH (design), based on a bulk density of 38-42 PCF and a 1/4" minus material size. The Conveyor shall have the following specifications:

Drive - 7.5 HP, 1750 RPM, 230/460 V, 3/60, TEXP motor, connected to a shaft mounted helical gear reducer assembly, having a Class II service factor, via a V-belt drive assembly, to yield the required belt speed. The drive is complete with a V-belt drive, fluid sheave, OSHA style guard, adjustable motor mount and torque arm assembly.

Belt Speed - 90 FPM.

V-Belt Guard - OSHA style, complete with mounting brackets.

V-Belt Tensioner - Adjustable motor base on the reducer.

Backstop - Internal type, integral with the reducer.

Drive Mount - At the conveyor head shaft.

Fluid Sheave - Non-delay fill type, for overload protection.

Belt - 42" wide, 2-ply, 220 PIW, with 3/16" x 1/16" RMA Grade II covers.

Splice - Field installed, vulcanized type (by others).

Carrying Idlers - CEMA "D", 6" diameter, 35° equal length roll troughing idlers with sealed roller bearings. The idlers shall be mounted on 4'-6" centers except at the skirtboards, where they shall be mounted on 2'-0" centers. One (1) 20° transition idler shall be provided just before the head pulley and just after the tail pulley. Idlers at the belt scale will be mounted on 3'-0" centers.

Impact Idlers - CEMA "D", 6" diameter, 35° equal length roll, rubber disc type, troughing idlers with sealed roller bearings. The idlers shall be mounted on 1'-0" centers at the load area.

Carrying Training Idlers - Not required.

Return Idlers - CEMA "D", 6" diameter, flat roll idlers with sealed roller bearings. The idlers shall be mounted on 10'-0" centers.

Return Training Idlers - Not required.

Head Pulley - 20" diameter x 46" face, positive crowned, welded steel conveyor pulley with "XT" hubs for 4 7/16" diameter shaft and 1/2" thick herringbone grooved lagging.

Tail Pulley - 18" diameter x 46" face, positive crowned, wing type, welded steel conveyor pulley with "XT" hubs for 3 15/16" diameter shaft.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearing pillow blocks with taconite seals, end caps, shims and adjustable base plates. One (1) fixed and one (1) floating per shaft.

Plugged Chute Switch - For location in the discharge chute, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the tail shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Safety Stop Switches - For location along both sides of the Conveyor, NEMA 9, cable operated, manual reset type, with required cable, support eyes and mounting hardware.

Belt Alignment Switches - NEMA 9, with mounting hardware. Two (2) sets included.

Belt Cleaners - Martin Engineering, Durt Tracker primary type with urethane blades and secondary type with segmented tungsten carbide blades, each complete with twist tensioners and inspection doors. All for location at the head pulley.

Take-Up - Screw type, complete with bearing as previously described and 24" of travel.

Conveyor Frame - Channel design, fabricated from mild steel structural shapes and plates with required spreaders.

Head Section - Included, channel frame construction.

Tail Section - Included, channel frame construction.

Deck Plate - No. 10 gauge mild steel, for location along the full length of the Conveyor.

Supports - Leg-type, fabricated from mild steel structural shapes and plates, for support of the Conveyor from grade.

Inlets - Two (2) fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners and external stiffening as required. The inlet is to be designed as an integral part of the skirtboards.

Skirtboards - 14'- 0" long, including the inlet, fabricated from 1/4" thick mild steel plate with continuous 1/2" thick adjustable rubber seals at the belt surface, No. 10 gauge mild steel covers, supports to the conveyor frame and flanged dust pick-up connection.

Discharge Hood - Fabricated from No. 10 gauge mild steel plate with inspection door, flanged discharge and flanged dust pick-up connection. The hood shall be split at the centerline of the head shaft.

Discharge Chute - Fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Nip Guards - Expanded metal type at the tail pulley.

Dust Curtains - Included, at both the exit from the skirtboards and the entrance to the discharge hood.

Walkway - 30" wide, located along one side of the Conveyor, for that portion of the Conveyor that is not accessible from grade, complete with two-rail handrail, toeboard, galvanized bar grating and access stairway.

Belt Scale - Three idler design, complete with the following major components:

Scale:
- Weighing platform constructed of 1/4" rectangular steel structural members supporting three weighing idlers.
- Four (4) check rods preventing lateral and horizontal movement, providing a stable platform for accurate weighing.
- Two (2) weather-proof enclosures on each end of the weighing platform that serve as load cell bridges.
- Four (4) precision strain gauge load cells with overload protection, supporting the weighing platform. Five feet of flexible connecting conduit is included.
- Three (3) weigh idlers.

Integrator:

- Microprocessor based integrator with count rates to 200,000 counts per hour.
- Four (4) line x twenty (20) character alpha-numeric display indicating total weight, flow-rate and selectable belt speed or belt loading.
- Simple keyboard entry of all calibration data with menu-driven prompting from the display.
- Auto zero actuated by a simple keystroke (or remote pushbutton) to tare the scale.
- Auto span actuated by a simple keystroke to calibrate the scale.
- Auto zero tracking can be enabled via the front keypad an allows fully automatic zero at a selectable flow rate up to 10%.
- Solid state pulse output gives one pulse per each increase of the lease significant digit of total.
- Alarm contact outputs for load, speed or rate and system failure.
- Full diagnostics to confirm proper operation of the scale system.
- Five (5) expansion slots for optional analog or communications requirements.
- NEMA 4X enclosure or DIN 43700 panel mount.
- Power required 110/120/220/240 VAC, (switch selectable) 50-60 Hz, 25 VA.
- Includes provisions to electronically simulate a loaded belt.
- Includes one (1) 4-20 mA analog output board.

Load Cell Digitizer:

- Provides load cell excitation and converts the load cell output signal to digitized output signal for use in the integrator.
- NEMA 9 enclosure.
- Requires 110/120/220/240 VAC (switch selectable) 50-60 Hz.

Belt Speed Sensor:

- Digital, brushless
- NEMA 9 enclosure

Static Calibration Weights:

- Set of static calibration weights to simulate approximately 50% of full scale, belt loading. Also included is a mechanical weight-lifting device (manually operated) for storage an impingement of static calibration weights.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Head Sprockets - 8 tooth, 31.36" P.D., solid hub, chilled rim type, fabricated from a chill iron cast material, induction case-hardened and bored and keyed as required.

Tail Wheels - 29" diameter, solid hub, chilled rim, segmented type, bored and keyed as required.

Intermediate Casing - Single stand design, 30" x 54 1/2", fabricated from No. 10 gauge mild steel plate complete with flanges and inspection door on first casing section above the boot section. Casing is fabricated with heavy duty corner angles, chain guides and external stiffeners.

Head Section - Fabricated from 1/4" thick mild steel plate and structural shapes, complete with No. 12 gauge mild steel two-piece hood, inspection door and a flanged discharge.

Boot Section - Fabricated from 1/4" thick mild steel plate complete with clean-out doors on the front and back, hinged access doors on each side, take-up hoist beam, 3/8" thick mild steel bottom plate and flanged inlet.

Inlet - Fabricated from 1/4" thick mild steel plate, with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Discharge - Fabricated from 1/4" thick mild steel plate, with 1/4"/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Discharge Chute - To SynCoal Sampler, fabricated from 1/4" thick mild steel plate, complete with flanges and 1/4/1/8" thick Triten T200X plate liners on sliding/impact wear surfaces. Liners bolted/welded in place.

Dust Collection Nozzle - One (1) provided for location at the head section, flanged, fabricated from No. 10 gauge mild steel.

Sway Bracing - Fabricated from mild steel shapes and plates for lateral bracing to building steel (by others) on approximately 20'-0" centers.

Plugged Chute Switch - For location at the discharge, NEMA 9, tilt type, with control unit and standard probe.

Zero Speed Switch - For location at the boot shaft assembly, NEMA 9, rotary motion type, with required guard and mounting hardware.

Access Platform - Not included. See Options.

Ladder/Cage/Rest Platforms - Not included. See Options.

Assembly Bolts - Included, A307.

Surface Preparation - SSPC-SP6 commercial grade blast cleaning.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The head section and drive shall be shop assembled. The boot section shall be shop assembled. The casing shall be assembled in 10'-0" lengths. The cups and chain will be shipped loose. The zero speed switch and the plugged chute switch shall ship loose. The sway bracing and discharge chute shall ship separate. All assembly bolts shall be boxed and tagged. All items shipped unassembled shall be match-marked and/or identified.

ESTIMATED WEIGHT - 64,490 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **Sampling System,** for location at the discharge of the SynCoal Bucket Elevator, single stage design, capable of sampling the SynCoal product, based upon taking 35 primary samples out of the lot size of 1,000 ton, which will result in a laboratory sample of 130.6 pounds every 11.9 hours of running time. The Sampling System shall have the following specifications:

- Primary Sampler, self contained, dust-tight modular machine. The housing is fabricated from mild steel plate, with a flanged in and outfeed, hinged access doors with adjustable quick cam latches, 12 pound crane rail for sample cutter wheels, mild steel baffle, seal plate, guards and seals, flanged sample discharge housing with type 304 stainless steel liners on coal contact surfaces and mechanical drive mounted on the housing. The sample cutter is fabricated from type 304 stainless steel, has adjustable cutter lips with a cutter opening set for 1.5", sample cutter support wheels and cutter discharge angle of 60° degree. The Drive is a mechanical type, 1 HP, with the drive speed set for 15 IPS.
- Sample Collector, rotary type, with four (4) stations. The main frame is fabricated from mild steel plates and structural shapes, and includes the turntable bearings and drive mount. The turntable is fabricated from mild steel and includes a polyethylene seal plate, sample can attachments and seals. Four (4) NEMA 9 proximity type limit switches are included. The drive is a 1/2 HP.
- Control Panel, NEMA 4, for wall mounting in a control room, 120/1/60 control voltage, including fuse block and fuse, timer(s), relay(s) and indicating light(s).
- The paint shall be the manufacturer's standard system.

ESTIMATED WEIGHT - 2,500 lbs.

Wolf and Associates, Inc.
MATERIAL HANDLING SYSTEMS
4860 Mustang Circle, St. Paul, MN 55112
(612) 780-4550 / Fax (612) 784-0097

- TECHNICAL SPECIFICATIONS -

1 - **SynCoal Storage Infeed Diverter Valve (Item No. DV-6906),** two-way design, air cylinder operated type, for location at the discharge of the Sampling System to allow SynCoal to be diverted to either of the two (2) SynCoal Storage Bins (Bins by others). The Diverter shall have the following specifications:

Slope - 60° minimum.

Construction - Housing fabricated from 1/4" thick mild steel plate with 1/4" thick mild steel flop gate, with 1/4"/1/8" thick Triten T200X plate liners on gate and at all sliding/impact wear surfaces. Liners bolted/welded in place.

Shafting - C-1045, cold rolled steel, turned and ground.

Bearings - Anti-friction, self-aligning, roller bearings with taconite seals and end caps.

Gate Actuator - Pneumatic type, air cylinder, with explosion proof solenoid valve.

Position Indicators - Two (2) NEMA 9, limit switch type.

Chutes - Two (2) required, fabricated from 1/4" thick mild steel plate with 1/4"/1/8" thick Triten T200X plate liners at all sliding/impact wear surfaces. Liners bolted/welded in place.

Assembly Bolts - Included, A307.

Finish - One (1) shop coat of Carboline 893 (Sumadur 893), 5 mil DFT and one (1) finish coat of Carboline 134 HS (Sumathane 834) aliphatic acrylic polyurethane coating 2 mil DFT.

Assembly - The Diverter Valve is assembled. The chutes are shipped separate.

ESTIMATED WEIGHT - 22,060 lbs.

APPENDIX B-2

HEAT EXCHANGER SPECIFICATIONS

Heat Exchanger Equipment
Definition and Performance Specification - 07063.01-P231F
Revision 0

Introduction

You are invited to propose on the Heat Exchangers and associated equipment. Included in or with this memorandum, for your use in developing a bid package, are: a system description; heat exchanger data sheets; design criteria for engineered equipment and thermal insulation; and diagrams of the heat exchanger system. Scope and specification of the equipment and services to be included in your proposal is described below.

Description

SynCoal and upgraded fuel produced from lignite coal, will be produced at a new facility at Minnkota Power Cooperative's Milton R. Young Power Station which is located near Center, North Dakota. The SynCoal will be added as a fuel supplement to existing lignite coal feed to Unit No. 1 and Unit No. 2 boilers located at the power station. The equipment requested is a series of five (5) in-duct finned tube heat exchangers intended to heat two (2) separate gas loops in conjunction with the SynCoal production process. Both loops utilize high pressure, high temperature main steam from Unit No. 2. The two loops are for heating Reactor gas and Dryer gas.

The Reactor loop utilizes desuperheating and condensing type heat exchangers. The steam flows first through the desuperheating exchanger. When the steam exits, it is conditioned (by others) before entering the condensing exchanger. The condensing heat exchanger drains through a drain tank to a subcooling heat exchanger in the Dryer loop.

The Dryer loop utilizes condensing and subcooling type heat exchangers. The steam first flows through a steam conditioning station (by others) then flows directly into the condensing exchanger. The condensing exchanger drains through a drain tank to a subcooling exchanger with is placed in the Dryer gas stream in parallel with the aforementioned subcooling exchanger from the Reactor loop.

Both sets of exchangers will be placed in ductwork for vertical gas flow with the gas flowing upward. Due to the heavy dust loading, sootblowers will be utilized to keep the finned tubing clean. Adequate spacing is to be allowed for their installation. Blowing medium will be nitrogen. Nitrogen will be supplied at 90 psig to others by the pickup point. The bidder is to provide the sootblower manufacturers standard offering for interface with the plant control system.

Thermal insulation and lagging will be supplied by others, the vendor will supply insulation supports per the attached per the thermal insulation design guide.

Design and performance bases are included in the attached documents.

Scope

The successful bidder shall provide all of the equipment and appurtenances as described herein:

1. Furnished by the Vendor

A.	Dryer Gas Heater -Condensing	HX-3601
B.	Dryer Subcooling Heat Exchanger	HX-3602A
C.	Reactor Subcooling Heat Exchanger	HX-3602B
D.	Reactor Gas Heater-Desuperheating	HX-3611
E.	Reactor Gas Heater-Condensing	HX-3612
F.	Sootblowers and Controls	
G.	Attachments for Thermal Insulation	
H.	Mechanical Drawings	
I.	O & M Manuals	
J.	Test Reports	
K.	Technical Support	

2. Owner Furnished:

   A. All inlet/outlet steam/drain piping and gas ductwork
   B. Installation of equipment
   C. Thermal insulation and installation thereof
   D. All instrument, drain and vent valving and piping
   E. Storage at the site
   F. 90 psig Nitrogen for Sootblowers
   G. Shipping
   H. Plant Control System

Bid Proposal

All proposals shall include as a minimum:

A. Equipment cost, including breakout pricing for individual heat exchangers and the total for sootblowers
B. Breakout pricing for nitrogen compression and storage for sootblowers, if required
C. Estimate freight to the site
D. Quantities, sizes, and manufacturers of sootblowers and sootblower nitrogen requirements
E. Completed data sheets showing all physical and thermal data
F. Sketches showing the physical arrangement of heaters within each respective duct, including required pull-space and number and locations of major inlet/outlet connections and sootblower locations.
G. Expected delivery time from receipt of order
H. Sootblower manufacturers standard offering for control interfacing with plant.

Attached Documents

Flow Diagram of Reactor/Dryer Gas Heating System
In-Duct Heater Arrangement Diagram
Dryer and Reactor Loop Particulates
Heat Exchanger Data Sheets (5)

Western SynCoal Documents:
DB-11 Guidelines for Design of Engineered Equipment
DB-07 Thermal Insulation

Copies of bid proposals are due not later than March 14, 1997 at 12:00 noon MST at Western Energy Company, with copies to Stone and Webster Engineering Corporation and UniField Engineering, Incorporated.

Western Energy Company
P.O. Box 99
Castle Rock Road
Colstrip, MT 59323
Phone: (406) 748-5151, Fax: (406) 748-5115

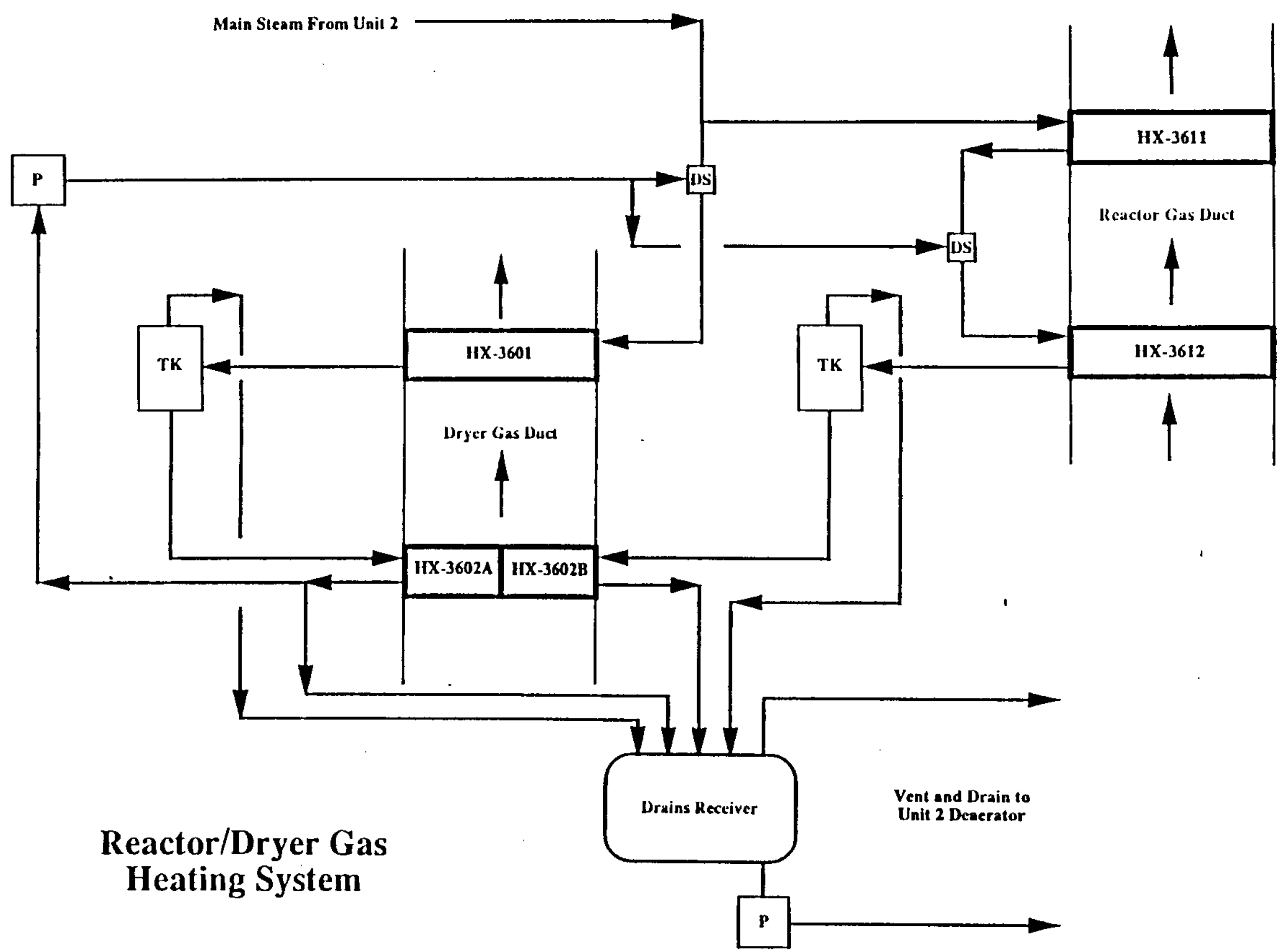
Attention: Charlie Vincent / Bill Pittman

Stone & Webster Engineering Corporation
7677 East Berry Avenue
Englewood, CO 80111-2137
Fax (303) 741-7670 or 741-7040

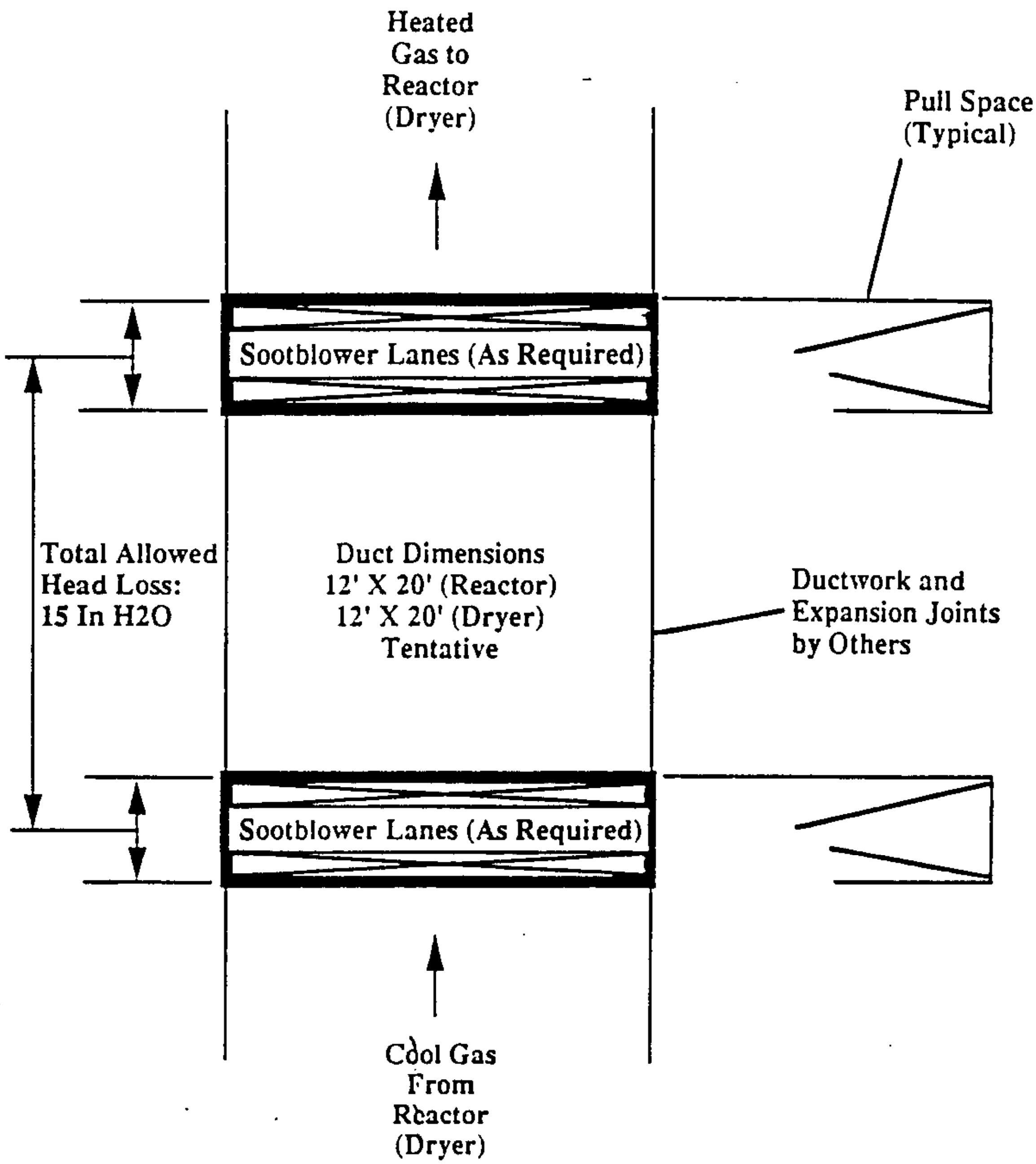
Attention: Gordon Webster / Rick Houston / Paul D'Errico

UniField Engineering, Inc.
2626 Lillian Avenue
Billings, MT 59101
Fax (406) 245-7112

Attention: Steven Henderson / Clinton Camper



Reactor/Dryer Gas
Heating System



In-duct Heater Arrangement

Dryer and Reactor Loop Particulates

Average Particulate Size, Microns	Maximum Particulate Loads, Lbs/Hr To Dryer HX's	To Reactor HX's
2.5	4,904	3,180
3.0	2,087	1,080
3.5	1,787	651
4.0	1,288	489
4.5	768	452
5.0	589	356
5.5	347	285
6.0	277	232
6.5	225	127
7.5	257	223
8.5	146	226
10.0	137	165
12.0	55	45
14.0	36	31
19.0	39	37
39.0	8	11
	12,950	7,590

Minimum particulate loads are 1/3 of the above values.

STONE AND WEBSTER ENGINEERING CORPORATION
HEAT EXCHANGER DATA

J.O. No. 07063.01
Date 2/27/97 By PAD
Item No. HX-3601

Client	Western Syncoal Company		
Project and Location	Center Syncoal Project, Center, North Dakota		
Service	Dryer Gas Heater - Condensing	Manufacturer	
Operating Case	Design	Mfr's Size & Type	
Size of Each Duct	Note 5	No. of Units 1	Ducts/Unit 1
Surface/Duct - Finned	SqFt:	Bare Tube	SqFt
Duty/ Duct	29.36 MMBtu/Hr	Mtd.Eff	deg F
Transfer Rate - Finned	: Bare Tube, Service	Clean	Btu/Hr-SqFt-deg F

PERFORMANCE DATA FOR ONE DUCT
TUBE SIDE

Fluid Circulated	Saturated Steam/Condensate					IN	OUT
Total Fluid Entering	63037	Lb/Hr		Density, Liquid, Lb/CuFt			
	IN		OUT	Specific Heat, Btu/Lb-deg F			
Temperature, F	665		648.78	Cond. (Liq/Vap), Btu/Hr-Ft-deg F			
Liquid Lb/Hr				Saturation Temperature, deg F			
Vapor Lb/Hr, MW				Latent Heat, Btu/Lb			
Noncond. Lb/Hr, MW				Inlet Pressure, (Psia)		2200	
Steam Lb/Hr	63037			Pressure Drop, Allow./Calc'd, Psi		10	
Water Lb/Hr			63037	Foul Resist, Inside, Hr-SqFt-deg F/Btu		0.001	
Viscosity (Liq/Vap), CP				Enthalpy, Btu/Lb		1159.97	694.24

GAS SIDE (See Note 1)

Direction of Gas Flow	Upward	Temperature In, deg F	418.4
Gas Flow/Duct, SCFM		Temperature Out, Deg F	550
Gas Flow, Lb/Hr	469,080	Altitude, Ft ASL	Note 2
Face Velocity, STD Ft/Min		Press. Drop, Allow./Calc'd, In. H2O	Note 7
Mass Velocity(Net Free Area), Lb/Hr-SqFt		Fouling Resist., Hr-SqFt-deg F/Btu	0.05

DESIGN - MATERIALS - CONSTRUCTION (See Note 6)

Tubeside Design Pressure, Psig 2400	Tubeside Test Pressure, Psig per code	Tubeside Design Temperatre, deg F 775
Gas Side Design Pressure -1 to +4 Psig	Minimum Ambient Temp, deg F -20	Gas Side Design Temperature, deg F 650
TUBE BUNDLE	**HEADER**	**TUBES**
Size, HxWxD, Ft-In Rows	Type	Material CS
No. of Bundles/Duct	Material CS ASTM No.	ASTM No. Seamless-Welded
No. of Bundles/Boiler Unit	No. of Passes/Bundle Slope In/Ft	OD BWG, Ave - Min Wall
BUNDLE ARRANGEMENT	Plug Design Material	No./Bundle Length, Ft-In
Vertical-Horizontal Tubes	Gasket Material	Pitch In.
Vertical-Horizontal Headers	Code ASME VIII Div. 1	Tube Joint Type
Bundles Connected in Parallel/Duct	Stamp (Yes, No) Yes	**FINS**
Bundles Connected in Series/Duct	Corrosion Allowance, In Note 4	Material
No. of Bundles Across Duct	No./Size Inlet Nozzles, In. Nom.	ASTM No.
No. of Bundles Deep in Direction of Air Flow	No./Size Outlet Nozzles, In. Nom.	OD, In.
Shipping Weight/Bundle, Lbs	Rating	Stock Thk, In.
Flooded Weight/Bundle, Lbs	**CASING**	No./In.
Bundle Removal Space, Ft-In	Material	Fin Design Temperature, deg F
Overall Heater Dimensions, HxWxD, Ft-In	Thickness, In.	Type
See Note 3 for additional requirements.		

NOTES

1. Gas Composition: 97 Vol % Water (Steam), 1.5 Vol % CO2, 1.5 Vol % N2. See attached data for dust loading.
2. Site atmospheric pressure is 13.7 psia. Gas side operating pressure is approximately 16 psia.
3. Sootblowers and appropriate lanes for sootblowers to be provided by Manufacturer. Sootblowing medium will be Nitrogen supplied at 90 Psig.
4. Corrosion allowances: 0.0625" tubeside; 0.125" gas side.
5. Tentative duct dimensions are 12 Ft x 20 Ft. Subject to later adjustment.
6. Small amounts of Chlorides are normally present in the gas. During shutdown, however, they are present in greater quantities in condensate. Stress corrosion cracking after repeated exposure over time of stainless steels is a concern. Therefore, stainless steel is not an acceptable material of construction for pressure retaining parts.
7. The total allowable pressure loss through this heater and the other parallel heaters in the same duct, HX-3602A & B, is 15 in. wc.

REV.	(0)	(1)	(2)	(3)	(4)	(5)

STONE AND WEBSTER ENGINEERING CORPORATION
HEAT EXCHANGER DATA

J.O. No. 07063.01
Date 2/27/97 By PAD

Client	Western Syncoal Company	Item No.	HX-3602A
Project and Location	Center Syncoal Project, Center, North Dakota		
Service	Dryer Subcooling Heat Exchanger	Manufacturer	
Operating Case	Design	Mfr's Size & Type	
Size of Each Duct	Note 5 (Installed in parallel with HX-3602B)	No. of Units 1	Ducts/Unit 1
Surface/Duct - Finned	SqFt:	Bare Tube	SqFt
Duty/ Duct	21.18 MMBtu/Hr	Mtd.Eff	deg F
Transfer Rate - Finned	; Bare Tube, Service	Clean	Btu/Hr-SqFt-deg F

PERFORMANCE DATA FOR ONE DUCT

TUBE SIDE

Fluid Circulated	Saturated/Subcooled Condensate						
Total Fluid Entering		62866 Lb/Hr		Density, Liquid, Lb/CuFt			
	IN		OUT			IN	OUT
Temperature, F	648.12		380		Cond. (Liq/Vap), Btu/Hr-Ft-deg F		
Liquid Lb/Hr					Saturation Temperature, deg F		
Vapor Lb/Hr, MW					Latent Heat, Btu/Lb		
Noncond. Lb/Hr, MW					Inlet Pressure, (Psia)	2180	
Steam Lb/Hr					Pressure Drop, Allow./Calc'd, Psi	20	
Water Lb/Hr	62866		62866		Foul Resist. Inside, Hr-SqFt-deg F/Btu	0.001	
Viscosity (Liq/Vap), CP					Enthalpy, Btu/Lb	693.07	356.15

Specific Heat, Btu/Lb-deg F: (IN) — (OUT) —

GAS SIDE (See Note 1)

Direction of Gas Flow	Upward	Temperature In, deg F	222
Gas Flow/Duct, SCFM		Temperature Out, Deg F	418.4
Gas Flow, Lb/Hr	224,455	Altitude, Ft ASL	Note 2
Face Velocity, STD Ft/Min		Press. Drop, Allow./Calc'd, In. H2O	Note 7
Mass Velocity(Net Free Area), Lb/Hr-SqFt		Fouling Resist., Hr-SqFt-deg F/Btu	0.05

DESIGN - MATERIALS - CONSTRUCTION (See Note 6)

Tubeside Design Pressure, Psig 2300	Tubeside Test Pressure, Psig per code	Tubeside Design Temperature, deg F 675
Gas Side Design Pressure -1 to 4 Psig	Minimum Ambient Temp, deg F -20	Gas Side Design Temperature, deg F 500
TUBE BUNDLE	**HEADER**	**TUBES**
Size, HxWxD, Ft-In Rows	Type	Material CS
No. of Bundles/Duct	Material CS ASTM No.	ASTM No. Seamless-Welded
No. of Bundles/Boiler Unit	No. of Passes/Bundle Slope In/Ft	OD BWG, Ave - Min Wall
BUNDLE ARRANGEMENT	Plug Design Material	No./Bundle Length, Ft-In
Vertical-Horizontal Tubes	Gasket Material	Pitch In.
Vertical-Horizontal Headers	Code ASME VIII Div. 1	Tube Joint Type
Bundles Connected in Parallel/Duct	Stamp (Yes, No) Yes	**FINS**
Bundles Connected in Series/Duct	Corrosion Allowance, In Note 4	Material
No. of Bundles Across Duct	No./Size Inlet Nozzles, In. Nom.	ASTM No.
No. of Bundles Deep in Direction of Air Flow	No./Size Outlet Nozzles, In. Nom.	OD, In.
Shipping Weight/Bundle, Lbs	Rating	Stock Thk, In.
Flooded Weight/Bundle, Lbs	**CASING**	No./In.
Bundle Removal Space, Ft-In	Material	Fin Design Temperature, deg F
Overall Heater Dimensions, HxWxD, Ft-In	Thickness, In.	Type
See Note 3 for additional requirements.		

NOTES

1. Gas Composition: 97 Vol % Water (Steam), 1.5 Vol % CO2, 1.5 Vol % N2. See attached data for dust loading.
2. Site atmospheric pressure is 13.7 psia. Gas side operating pressure is approximately 16 psia.
3. Sootblowers and appropriate lanes for sootblowers to be provided by Manufacturer. Sootblowing medium will be Nitrogen supplied at 90 Psig.
4. Corrosion allowances: 0.0625" tubeside; 0.125" gas side.
5. Tentative duct dimensions are 12 Ft x 20 Ft. Subject to later adjustment.
6. Small amounts of Chlorides are normally present in the gas. During shutdown, however, they are present in greater quantities in condensate. Stress corrosion cracking after repeated exposure over time of stainless steels is a concern. Therefore, stainless steel is not an acceptable material of construction for pressure retaining parts.
7. Since this heater is installed in parallel with HX-3602B with respect to the gas flow, gas-side pressure losses must match to allow proper gas flow through each heater. The total allowable pressure loss through these two parallel heaters and the other heater in the same duct, HX-3601, is 15 in. wc.

REV.	(0)	(1)	(2)	(3)	(4)	(5)

STONE AND WEBSTER ENGINEERING CORPORATION
HEAT EXCHANGER DATA

J.O. No. 07063.01
Date 2/27/97 By PAD

Client	Western Syncoal Company			Item No.	HX-3602B
Project and Location	Center Syncoal Project, Center, North Dakota				
Service	Reactor Subcooling Heat Exchanger	Manufacturer			
Operating Case	Design	Mfr's Size & Type			
Size of Each Duct	Note 5 (Installed in parallel with HX-3602A)	No. of Units	1	Ducts/Unit	1
Surface/Duct - Finned	SqFt:	Bare Tube		SqFt	
Duty/ Duct	23.09 MMBtu/Hr	Mtd.Eff		deg F	
Transfer Rate - Finned	; Bare Tube, Service		Clean	Btu/Hr-SqFt-deg F	

PERFORMANCE DATA FOR ONE DUCT
TUBE SIDE

Fluid Circulated	Saturated/Subcooled Condensate					IN	OUT
Total Fluid Entering	70461		Lb/Hr		Density, Liquid, Lb/CuFt		
	IN		OUT		Specific Heat, Btu/Lb-deg F		
Temperature, F	642.75		380		Cond. (Liq/Vap), Btu/Hr-Ft-deg F		
Liquid Lb/Hr					Saturation Temperature, deg F		
Vapor Lb/Hr, MW					Latent Heat, Btu/Lb		
Noncond. Lb/Hr, MW					Inlet Pressure, (Psia)	2100	
Steam Lb/Hr					Pressure Drop, Allow./Calc'd, Psi	20	
Water Lb/Hr	70461		70461		Foul Resist, Inside, Hr-SqFt-deg F/Btu	0.001	
Viscosity (Liq/Vap), CP					Enthalpy, Btu/Lb	683.76	356.04

GAS SIDE (See Note 1)

Direction of Gas Flow	Upward	Temperature In, deg F	222
Gas Flow/Duct, SCFM		Temperature Out, Deg F	418.4
Gas Flow, Lb/Hr	244,625	Altitude, Ft ASL	Note 2
Face Velocity, STD Ft/Min		Press. Drop, Allow./Calc'd, In. H2O	Note 7
Mass Velocity(Net Free Area), Lb/Hr-SqFt		Fouling Resist., Hr-SqFt-deg F/Btu	0.05

DESIGN - MATERIALS - CONSTRUCTION (See Note 6)

Tubeside Design Pressure, Psig 2300	Tubeside Test Pressure, Psig per code	Tubeside Design Temperature, deg F 675
Gas Side Design Pressure -1 to 4 Psig	Minimum Ambient Temp, deg F -20	Gas Side Design Temperature, deg F 500
TUBE BUNDLE	**HEADER**	**TUBES**
Size, HxWxD, Ft-In Rows	Type	Material CS
No. of Bundles/Duct	Material CS ASTM No.	ASTM No. Seamless-Welded
No. of Bundles/Boiler Unit	No. of Passes/Bundle Slope In/Ft	OD BWG, Ave - Min Wall
BUNDLE ARRANGEMENT	Plug Design Material	No./Bundle Length, Ft-In
Vertical-Horizontal Tubes	Gasket Material	Pitch In.
Vertical-Horizontal Headers	Code ASME VIII Div. 1	Tube Joint Type
Bundles Connected in Parallel/Duct	Stamp (Yes, No) Yes	**FINS**
Bundles Connected in Series/Duct	Corrosion Allowance, In Note 4	Material
No. of Bundles Across Duct	No./Size Inlet Nozzles, In. Nom.	ASTM No.
No. of Bundles Deep in Direction of Air Flow	No./Size Outlet Nozzles, In. Nom.	OD, In.
Shipping Weight/Bundle, Lbs	Rating	Stock Thk, In.
Flooded Weight/Bundle, Lbs	**CASING**	No./In.
Bundle Removal Space, Ft-In	Material	Fin Design Temperature, deg F
Overall Heater Dimensions, HxWxD, Ft-In	Thickness, In.	Type
See Note 3 for additional requirements.		

NOTES

1. Gas Composition: 97 Vol % Water (Steam), 1.5 Vol % CO2, 1.5 Vol % N2. See attached data for dust loading.
2. Site atmospheric pressure is 13.7 psia. Gas side operating pressure is approximately 16 psia.
3. Sootblowers and appropriate lanes for sootblowers to be provided by Manufacturer. Sootblowing medium will be Nitrogen supplied at 90 Psig.
4. Corrosion allowances: 0.0625" tubeside; 0.125" gas side.
5. Tentative duct dimensions are 12 Ft x 20 Ft. Subject to later adjustment.
6. Small amounts of Chlorides are normally present in the gas. During shutdown, however, they are present in greater quantities in condensate. Stress corrosion cracking after repeated exposure over time of stainless steels is a concern. Therefore, stainless steel is not an acceptable material of construction for pressure retaining parts.
7. Since this heater is installed in parallel with HX-3602A with respect to the gas flow, gas side pressure losses must match to allow proper gas flow through each heater. The total allowable pressure loss through these two parallel heaters and the other heater in the same duct, HX-3601, is 15 in. wc.

REV.	(0)	(1)	(2)	(3)	(4)	(5)

STONE AND WEBSTER ENGINEERING CORPORATION
HEAT EXCHANGER DATA

J.O. No.	07063.01
Date	2/27/97 By PAD

1	Client	Western Syncoal Company		Item No.	HX-3611
2	Project and Location	Center Syncoal Project, Center, North Dakota			
3	Service	Reactor Gas Heater - Desuperheating	Manufacturer		
4	Operating Case	Design	Mfr's Size & Type		
5	Size of Each Duct	Note 5	No. of Units 1	Ducts/Unit	1
6	Surface/Duct - Finned	SqFt:	Bare Tube	SqFt	
7	Duty/ Duct	18.08 MMBtu/Hr	Mtd.Eff	deg F	
8	Transfer Rate - Finned	; Bare Tube, Service	Clean	Btu/Hr-SqFt-deg F	

9 **PERFORMANCE DATA FOR ONE DUCT**

10 **TUBE SIDE**

11	Fluid Circulated		Superheated Steam				IN	OUT
12	Total Fluid Entering		68124	Lb/Hr	Density, Liquid, Lb/CuFt			
13			IN	OUT	Specific Heat, Btu/Lb-deg F			
14	Temperature, F		989	680	Cond. (Liq/Vap), Btu/Hr-Ft-deg F			
15	Liquid	Lb/Hr			Saturation Temperature, deg F			
16	Vapor	Lb/Hr, MW			Latent Heat, Btu/Lb			
17	Noncond.	Lb/Hr, MW			Inlet Pressure, (Psia)		2200	
18	Steam	Lb/Hr	68124	68124	Pressure Drop, Allow./Calc'd, Psi		50	
19	Water	Lb/Hr			Foul Resist. Inside, Hr-SqFt-deg F/Btu		0.001	
20	Viscosity (Liq/Vap), CP				Enthalpy, Btu/Lb		1460.4	1195

21 **GAS SIDE (See Note 1)**

22	Direction of Gas Flow	Upward	Temperature In, deg F	635.33
23	Gas Flow/Duct, SCFM		Temperature Out, Deg F	750
24	Gas Flow, Lb/Hr	322,180	Altitude, Ft ASL	Note 2
25	Face Velocity, STD Ft/Min		Press. Drop, Allow./Calc'd, In. H2O	Note 7
26	Mass Velocity(Net Free Area), Lb/Hr-SqFt		Fouling Resist., Hr-SqFt-deg F/Btu	0.05

27 **DESIGN - MATERIALS - CONSTRUCTION (See Note 6)**

3	Tubeside Design Pressure, Psig 2400	Tubeside Test Pressure, Psig per code	Tubeside Design Temperature, deg F 1005
9	Gas Side Design Pressure -1 to 4 Psig	Minimum Ambient Temp, deg F -20	Gas Side Design Temperature, deg F 800
30	**TUBE BUNDLE**	**HEADER**	**TUBES**
31	Size, HxWxD, Ft-In Rows	Type	Material Cr-Mo
32	No. of Bundles/Duct	Material Cr-Mo ASTM No.	ASTM No. Seamless-Welded
33	No. of Bundles/Boiler Unit	No. of Passes/Bundle Slope In/Ft	OD BWG, Ave - Min Wall
34	**BUNDLE ARRANGEMENT**	Plug Design Material	No./Bundle Length, Ft-In
35	Vertical-Horizontal Tubes	Gasket Material	Pitch In.
36	Vertical-Horizontal Headers	Code ASME VIII Div. 1	Tube Joint Type
37	Bundles Connected in Parallel/Duct	Stamp (Yes, No) Yes	**FINS**
38	Bundles Connected in Series/Duct	Corrosion Allowance, In Note 4	Material
39	No. of Bundles Across Duct	No./Size Inlet Nozzles, In. Nom.	ASTM No.
40	No. of Bundles Deep in Direction of Flow	No./Size Outlet Nozzles, In. Nom.	OD, In.
41	Shipping Weight/Bundle, Lbs	Rating	Stock Thk, In.
42	Flooded Weight/Bundle, Lbs	**CASING**	No./In.
43	Bundle Removal Space, Ft-In	Material	Fin Design Temperature, deg F
44	Overall Heater Dimensions, HxWxD, Ft-In	Thickness, In.	Type
45	**See Note 3 for additional requirements.**		

46 **NOTES**

47 1. Gas Composition: 97 Vol % Water (Steam), 1.5 Vol % CO2, 1.5 Vol % N2. See attached data for dust loading.

48 2. Site atmospheric pressure is 13.7 psia. Gas side operating pressure is approximately 16 psia.

49 3. Sootblowers and appropriate lanes for sootblowers to be provided by Manufacturer. Sootblowing medium will be Nitrogen supplied at 90 Psig.

50 4. Corrosion allowances: 0.0625" tubeside; 0.125" gas side.

51 5. Tentative duct dimensions are 12 Ft x 20 Ft. Subject to later adjustment.

52 6. Small amounts of Chlorides are normally present in the gas. During shutdown, however, they are present in greater quantities in condensate. Stress corrosion

53 cracking after repeated exposure over time of stainless steels is a concern. Therefore, stainless steel is not an acceptable material of construction for pressure

54 retaining parts.

55 7. The total allowable pressure loss through this heater and the other heater in the same duct, HX-3612, is 15 in. wc.

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REV.	(0)	(1)	(2)	(3)	(4)	(5)

STONE AND WEBSTER ENGINEERING CORPORATION
HEAT EXCHANGER DATA

J.O. No. 07063.01
Date 2/27/97 By PAD

1	Client	Western Syncoal Company		Item No. HX-3612
2	Project and Location	Center Syncoal Project, Center, North Dakota		
3	Service	Reactor Gas Heater - Condensing	Manufacturer	
4	Operating Case	Design	Mfr's Size & Type	
5	Size of Each Duct	Note 5	No. of Units 1	Ducts/Unit 1
6	Surface/Duct - Finned	SqFt	Bare Tube	SqFt
7	Duty/ Duct	33.92 MMBtu/Hr	Mtd.Eff	deg F
8	Transfer Rate - Finned	: Bare Tube, Service	Clean	Btu/Hr-SqFt-deg F

9 **PERFORMANCE DATA FOR ONE DUCT**

10 **TUBE SIDE**

11	Fluid Circulated	Saturated Steam/Condensate					IN	OUT
12	Total Fluid Entering		70645		Lb/Hr	Density, Liquid, Lb/CuFt		
13		IN		OUT		Specific Heat, Btu/Lb-deg F		
14	Temperature, F	660		643.43		Cond. (Liq/Vap), Btu/Hr-Ft-deg F		
15	Liquid Lb/Hr					Saturation Temperature, deg F		
16	Vapor Lb/Hr, MW					Latent Heat, Btu/Lb		
17	Noncond. Lb/Hr, MW					Inlet Pressure, (Psia)	2120	
18	Steam Lb/Hr	70645				Pressure Drop, Allow./Calc'd, Psi	10	
19	Water Lb/Hr			70645		Foul Resist, Inside, Hr-SqFt-deg F/Btu	0.001	
20	Viscosity (Liq/Vap), CP					Enthalpy, Btu/Lb	1165.07	684.92

21 **GAS SIDE (See Note 1)**

22	Direction of Gas Flow	Upward	Temperature In, deg F	415
23	Gas Flow/Duct, SCFM		Temperature Out, Deg F	635.33
24	Gas Flow, Lb/Hr	322,180	Altitude, Ft ASL	Note 2
25	Face Velocity, STD Ft/Min		Press. Drop, Allow./Calc'd, In. H2O	Note 7
26	Mass Velocity(Net Free Area), Lb/Hr-SqFt		Fouling Resist., Hr-SqFt-deg F/Btu	0.05

27 **DESIGN - MATERIALS - CONSTRUCTION (See Note 6)**

28	Tubeside Design Pressure, Psig 2300	Tubeside Test Pressure, Psig per code		Tubeside Design Temperature, deg F 775
29	Gas Side Design Pressure -1 to 4 Psig	Minimum Ambient Temp, deg F -20		Gas Side Design Temperature, deg F 675
30	**TUBE BUNDLE**	**HEADER**		**TUBES**
31	Size, HxWxD, Ft-In Rows	Type		Material CS
32	No. of Bundles/Duct	Material CS	ASTM No.	ASTM No. Seamless-Welded
33	No. of Bundles/Boiler Unit	No. of Passes/Bundle	Slope In/Ft	OD BWG, Ave - Min Wall
34	**BUNDLE ARRANGEMENT**	Plug Design	Material	No./Bundle Length, Ft-In
35	Vertical-Horizontal Tubes	Gasket Material		Pitch In.
36	Vertical-Horizontal Headers	Code	ASME VIII Div. 1	Tube Joint Type
37	Bundles Connected in Parallel/Duct	Stamp (Yes, No)	Yes	**FINS**
38	Bundles Connected in Series/Duct	Corrosion Allowance, In	Note 4	Material
39	No. of Bundles Across Duct	No./Size Inlet Nozzles, In. Nom.		ASTM No.
40	No. of Bundles Deep in Direction of Flow	No./Size Outlet Nozzles, In. Nom.		OD, In.
41	Shipping Weight/Bundle, Lbs	Rating		Stock Thk, In.
42	Flooded Weight/Bundle, Lbs	**CASING**		No./In.
43	Bundle Removal Space, Ft-In	Material		Fin Design Temperature, deg F
44	Overall Heater Dimensions, HxWxD, Ft-In	Thickness, In.		Type
45	**See Note 3 for additional requirements.**			

46 **NOTES**

47 1. Gas Composition: 97 Vol % Water (Steam), 1.5 Vol % CO_2, 1.5 Vol % N_2. See attached data for dust loading.
48 2. Site atmospheric pressure is 13.7 psia. Gas side operating pressure is approximately 16 psia.
49 3. Sootblowers and appropriate lanes for sootblowers to be provided by Manufacturer. Sootblowing medium will be Nitrogen supplied at 90 Psig.
50 4. Corrosion allowances: 0.0625" tubeside: 0.125" gas side.
51 5. Tentative duct dimensions are 12 Ft x 20 Ft. Subject to later adjustment.
52 6. Small amounts of Chlorides are normally present in the gas. During shutdown, however, they are present in greater quantities in condensate. Stress corrosion
53 cracking after repeated exposure over time of stainless steels is a concern. Therefore, stainless steel is not an acceptable material of construction for pressure
54 retaining parts.
55 7. The total allowable pressure loss through this heater and the other heater in the same duct, HX-3611, is 15 in. wc.
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REV.	(0)	(1)	(2)	(3)	(4)	(5)

WESTERN SYNCOAL

CENTER SYNCOAL FACILITY

GUIDE DESIGN BASES No. DB-11

Guidelines for Design of Engineered Equipment

REV.	DATE	BY	CHK	APPROVAL	DESCRIPTION
0	10/23/96	JSF		RWS	Issued For Bid Purposes

INDEX

1.0 INTRODUCTION

This document outlines the quality requirements for the Vendor's design, engineering, drawings, specifications, calculations, procedures and reports which are deliverable items under the purchase order.

For the purposes of this document. Vendor is defined as the entity with whom the purchase order is placed. Sub-Vendor is defined as suppliers of equipment and data to the Vendor. The Vendor has full responsibility for meeting the conditions of this document for all equipment and Engineering provided under the purchase by this Sub-Vendor.

It is the Vendor's responsibility to provide fully documented design engineering and to review, summarize and integrate any Sub-Vendor equipment and engineering into his final design.

2.0 SCOPE OF WORK

2.1 Services

Vendor shall provide all labor, supervision, administration and management necessary to design, fabricate and supply material and equipment to complete the work detailed in the specification to which this document is attached.

Principal services to be performed are as follows:

- Engineering and design
- Procurement of materials and equipment including delivery to nominated destination
- Shop fabrication
- Inspection
- Advisory assistance for construction, erection and inspection of the installation
- Operator training guidance for plant start-up and commissioning

2.2 Engineering and Design

Vendor shall complete all engineering calculations, general arrangement and detail design drawings, shop drawings, technical and equipment specifications and bill of material.

Organization and performance of planning and control procedures, progress monitoring and reporting; and over-all coordination of all engineering design functions to meet the approved schedule for the Work.

Preparation of operating manuals, and Information and Instructions pertaining to flow rates, capacities, limitations, electrical operations, safety devices, lubrication, maintenance, recommended spare parts inventories, start-up procedures, and special tool and equipment lists for maintenacne.

2.3 Procurement of Material and Equipment

Vendor shall be responsible for the purchase and shipment of all material and equipment required for mechanical, process and utility systems; inspection, testing and expediting of sub-orders, as required; supervision and contracted of all packing and shipping; and, coordination of all procurement functions to meet the over-all approved schedule for the Work.

2.4 Shop Fabrication

Vendor shall be responsible for the fabrication of all structural. plate and miscellaneous steel required for equipment structures: fabrication of all piping. stacks and ductwork required for mechanical. process and utility systems; and. coordination of all fabrication work to meet the overall schedule for the Work.

2.5 Advisory Assistance - Construction. Erection and Inspection

Vendor shall provide advisory personnel to participate with the Engineer in the construction. erection and inspecting of material and equipment. piping. electrical and instrumentation systems to confirm that installation is according to the written specifications. Vendor shall furnish a list of personnel (with qualifications) proposed to be assigned by Vendor and its sub-vendors for these services.

2.6 Personnel Training, Commissioning and Plant Start-up

Vendor responsibility shall include organization and supervision of a personnel training program for the Owner including recommendations for selection of personnel by the Owner. written procedures and instructions for operation and maintenance of the plant and selected units of equipment: and a planned program of in-plant training at existing facilities.

Vendor shall provide personnel for coordination services during performance tests and for plant start-up following acceptance of the Work. Vendor shall provide a list of the personnel (with qualifications) to be assigned by Vendor and sub-vendors for these services.

2.7 Miscellaneous

Vendor shall provide a list of recommended capital and operating spare parts. This list must be based on manufacturer's judgement. The list must recommend a reasonable amount of spares for two years of operation. Spare parts should be classified as required for:

- Normal Maintenance
- Normal Operation (spare parts or elements that wear out during operation)
- Emergency Spare Parts (long life parts subject to failure due to inexperience or abnormal conditions such as during start-up period. corrections. etc.)
- Exchange Units (units of equipment exchanged on a completely assembled basis)

Vendor shall provide a detailed program for preventive maintenance.

Vendor shall provide a list of lubricants and other charges required.

3.0 SCHEDULE OF THE WORK

Vendor shall. within thirty calendar days of date of written notice to proceed from the Engineer. submit for review and approval a complete schedule for each of the following parts of the Purchase Order. Each schedule shall be coordinated. as appropriate. with the others.

- Schedule I — Engineering and Design
- Schedule II — Procurement and Delivery of Materials and Equipment
- Schedule III — Shop Fabrication
- Schedule IV — Inspection. Training. Commissioning and Start-up

Schedules for procurement and supply of materials for instrumentation, electrical hardware and miscellaneous materials shall be constructed to show completion and delivery to jobsite per schedule submitted with proposal.

Schedules shall be prepared in sufficient detail to clearly illustrate anticipated progress of the various contract phases from design through final delivery, and all inter-dependencies shall be clearly shown or explained. The degree of detail shown for each phase shall be subject to acceptance of Engineer.

In addition to the above referenced schedule, Vendor shall submit a complete drawing list, a schedule of anticipated completion for the drawings and an engineering manpower curve.

Vendor shall obtain schedules from its sub-vendors as necessary for preparation of the above schedules or as requested by Engineer.

During execution of the work, Vendor shall promptly advise Engineer in writing of any deviation from the schedule. The submission of such schedules shall not relieve Vendor of any of its duties or responsibilities under the Purchase Order.

4.0 MONTHLY REPORTS BY VENDOR

Vendor shall prepare and submit by the twentieth day of each month a report to Engineer covering the current status of work for each phase of the Purchase Order such as, engineer, procurement, fabrication and delivery. Monthly cut-off date shall be coordinated with the Engineer.

The report shall be coordinated with the breakdown agreed for the schedule referenced herein and shall include a summary of work contemplated to be performed and/or completed during the next two months. One section of the monthly report shall deal exclusively with the subject of expediting.

5.0 EXPEDITING

Engineer and/or Owner reserve the right, to the extent deemed necessary, to participate in the expediting of materials and equipment to be furnished by Vendor's suppliers and sub-suppliers, and Vendor agrees to furnish all information and assistance necessary and arrange access to the plants and facilities of its suppliers as Engineer may require.

6.0 EQUIPMENT AND MATERIAL LISTS

Vendor shall provide complete lists (separate) of all equipment and material to be furnished under the Purchase Order.

The equipment list shall include all information on the function of the equipment, its basic size, power requirements, utility requirements and estimated weight. A list of proposed suppliers for the various equipment units shall be submitted.

Material lists provided shall be in the form of a bill of material showing quantities and full descriptions and shall be referenced to individual drawings.

For standardization of electrical equipment, see Guide Design Bases No. DB-16-A.

7.0 INSTRUMENTATION AND CONTROL SYSTEMS REQUIREMENTS

7.1 General

In general, all control instrumentation shall be solid state or microprocessor based electronic. Control signals shall be standardized wherever possible to allow interchangeability of components within different control loops.

All instruments, materials and controls shall be of the same make and design to minimize stocking of spare parts and to simplify operating and maintenance procedures. The Vendor shall select instruments, materials, and controls in accordance with "Instrument Vendor's List". If exceptions from the list are necessary, the Vendor shall submit such exceptions in writing to Engineer for approval.

The Vendor shall be responsible for the quality and performance of Instruments supplied by him.

All scales and ranges shall be furnished in foot-pound-second units.

The Vendor shall provide stainless steel tags for each instrument. The tags shall be attached to the instrument using stainless steel wire. Purchase order number, item number, and instrument tag number shall be shown on each tag.

For standardization of instruments, see Guide Design Basis DB-13.

.0 DRAWING AND DATA REQUIREMENTS

Vendor shall supply drawing and data information for all material and equipment included in the scope of work. This information shall be produced and supplied within and according to the time periods set forth in the approved engineering schedule.

The drawings and data submitted shall enable Engineer to:

- Verify that the materials and equipment meet the general requirements of the specifications without interfering with or limiting Vendor's obligations or proprietary rights.
- Accurately lay out the equipment relative to other equipment and structures, giving consideration to the Owner's operational and maintenance requirements.
- Design and install supply services necessary for operation of the equipment, for example: electric power, water and gas.
- Plan and schedule installation and erection procedures, equipment and personnel requirements as recommended by Vendor based upon American domestic practices.
- Verify that applicable requirements of government or other regulatory bodies have been met.

The drawings and data submitted shall enable the Owner to:

- Operate the equipment.
- Efficiently maintain and service the equipment.
- Identify all components of assemblies and subassemblies for maintenance and replacement.
- Purchase and maintain in stock all spare parts necessary for continuous operation.

Drawings and data sheets shall be supplied in specified form and quantities addressed. All submittals shall be in the English language.

9.0 INFORMATION AND DATA REQUIRED ON DRAWINGS

Each drawing and data sheet, prepared by Vendor or its suppliers must incorporate the following information:

- Drawing number, title and revision number.
- Name of project.
- Equipment number.
- Purchase Order Number (if established).
- Paint Specifications (if applicable).
- Applicable reference number for spare parts.

All drawings shall be prepared on standard sheets as follows:

30 x 42	E
24 x 36	D
18 x 24	C
11 x 17	B
8-1/2 x 11	A

All drawings when submitted as "final" must be certified. This may be done by stamping the prints with the words: "Certified Correct for Construction", accompanied by signature of responsible Engineer for the Vendor.

All operating manuals and final drawings must be furnished prior to shipment of the equipment.

10.0 DESCRIPTION OF DRAWINGS

10.1 Outline Drawings

Outline drawings must show at least the following:

- Outside dimensions of the assembly in vertical and horizontal planes.
- Basic equipment center lines.
- Clearances required for access to and removal of parts or sub-assemblies for maintenance.
- Minimum operating clearances for nearby permanent structure or equipment.
- Locations of all support structures required for the equipment.
- Locations, sizes and projection of all anchor bolts.
- Equipment loads and reactions, both vertical and horizontal, static and dynamic, at each fixing or support point.
- Total weight of materials and equipment including shipping weight and size of heaviest lift.
- If applicable, vibration data, e.g. unbalanced masses, frequency, and values of impact factors.

10.2 Cross Section with Parts Lists

Cross sections through all assemblies, sub-assemblies and components, with each part identified as to quantity, type, size, etc. must be in sufficient detail to enable the Owner to operate, service, dismantle, maintain and reassemble the equipment.

10.3 Drawings

Drawings shall conform to the following:

- Fabrication "shop detail" drawings shall be prepared by Vendor for the structural steel within the scope of supply.
- Detail drawings of equipment field assembled shall be complete to the extent of showing all member sizes, lengths, connection details, hole location and sizes, welding match marks and any other necessary information to enable fabrication and erection without additional detailing being required.
- Language of the arrangement, assembly and erection drawings shall be English.
- All wires and terminals shall be clearly numbers on the drawings. Power supply voltage, amperage and frequency shall be shown.
- Standard symbols must be used on all applicable drawings (especially schematics) and are subject to Engineer approval.

10.4 Arrangement Drawings

Arrangement Drawings shall include the following:

- General outlines of the assembly in plan and elevation.
- Basic center lines of the equipment.
- Locations of connections to adjacent equipment, and support, for example: water, gas, and electric power.
- Quantities, temperatures, pressures, or similar characteristics of support services required.
- Location, orientation, direction of rotation, and electrical characteristics of motors.
- Operator safety devices such as guards.
- Applicable piping, process, hydraulic and instrumentation diagrams showing all control or measuring devices, recorders, and all interconnecting piping, tubing, etc. All devices shall be identified and sizes of all piping conduit, tubing, etc., shall be shown.

10.5 Electrical Drawings

Electrical drawings to be supplied shall conform to Guide Design Bases DB-16-A, Electrical Design Criteria.

Electrical drawings shall include the following:

- Single-line diagrams
- Three line diagrams
- Elementary diagrams
- Interconnection diagrams
- Cable and conduit schedule
- Electrical room arrangement drawings
- Power and control layout between output terminals of MCC's control panels, operator stations, motors and instruments
- Lighting and grounding layouts

Elementary diagrams shall be in standard schematic form and show all electrical components and wiring required to enable the equipment to operate. The drawings must differentiate between wiring which is done in the shop and that which is to be done in the field.

10.6 Instrumentation Drawings

The Vendor shall prepare instrumentation drawings and data for efficient installation, start-up, calibration, maintenance and operation of instrumentation system. This shall include but not be limited to:

- Piping and instrument diagrams *
- Instrument loop diagrams *
- Panelboard general arrangement drawings and nameplate schedules *
- Instrument index *
- Instrument data sheets
- Instrument panel wiring and piping diagrams
- Interconnection diagrams
- Instrument installation details
- Start-up and calibration procedures
- Operations and maintenance procedures
- List of spare parts for two (2) year operation

The drawings noted with an asterisk (*) in Sections 10.5 and 10.6 shall be submitted to Engineer for approval prior to purchasing or manufacturing any item.

Instrument symbols, instrument numbering system, and wire numbering system shall be per Guide Design Bases DB-13, General Instrument Design.

The instrument number shall be assigned in numerical sequence within a block of numbers which will be assigned by Engineer.

The supplier shall furnish certified calibration reports for all applicable major control components and instrument items. Calibration shall be in accordance with Manufacturer's standard procedures.

11.0 CERTIFIED PERFORMANCE DATA

This information shall be comprised of fan curves, pump curves, and similar performance data, certified by the supplier to represent the performance which the supplier guarantees his equipment to meet. This information shall also include records of actual tests if they are performed.

Curves, methods and information of recommended instruments and tools where required for calibration of equipment or components shall be supplied where applicable.

12.0 APPROVAL OF VENDOR'S DRAWINGS AND DATA

Vendor's drawings and data shall be submitted to Engineer for approval as to arrangement, type and general size of materials or equipment, as well as general conformity to specifications.

Drawings and data for approval shall consist of the following:

- Flowsheets
- General arrangement drawings
- Major mechanical assembly drawings reflecting construction work and operation
- Heat and material balance sheets

- Piping and instrument diagrams
- Electrical single line diagrams
- Utility piping and instrument diagrams
- Structural steel drawings showing main steel members
- Interconnecting electrical and instrumentation drawings
- Equipment assembly and erection drawings, specifications and instructions including those prepared by sub-vendors

Vendor shall not forward any of the above drawings and data to the Engineer without first confirming to its own satisfaction that is conforms with the Purchase Order including, but not limited to, Engineer's drawings, general specifications, appendixes, mechanical guarantees, the performance warranty, and the approved schedule of work for Project.

Dimensional accuracy is the sole responsibility of the supplier of the drawings.

Engineer approval shall not relieve Vendor of responsibility for drawing correctness and suitability of materials, nor does it constitute approval of substitute materials or departures from contract drawings, specifications, revision thereto, or relevant codes.

Drawings and data returned to Vendor for revision or correction must be resubmitted in accordance with instructions shown on the approval stamp. The original drawing number must be retained, with only the revision number changed and all revisions shall be clearly identified on the drawing or data sheet.

If, for any reason, Vendor is unable to comply with comments shown on the returned drawings, Vendor shall immediately advise Engineer in writing.

13.0 CODE CERTIFICATES

These documents shall include any certificates required by governmental or other regulatory agency, certifying that the equipment or materials have been manufactured and tested in accordance with requirement of the specific agency in authority.

Where the originals of such certificates are required by regulation to be supplied directly to the final user, Vendor shall provide Engineer with copies of the certificates.

14.0 ERECTION AND INSTALLATION INSTRUCTIONS

These instructions shall include all information required by erection or installation crews to enable them to correctly and efficiently install the materials or equipment. The information shall include at least the following:

- Descriptive procedures or techniques, and installation specifications.
- Special tool or equipment requirements.
- Where materials and equipment are to be shipped, disassembled, drawing showing component mark numbers and match markings.
- Alignment, leveling or balancing requirements.
- Precautions to be taken by the erector or installer.
- Start-up instrucuons.

15.0 PLANT START-UP ADVISORY ASSISTANCE

Vendor shall provide start-up technicians in adequate number to advise and assist Engineer/Owner in the performance test and start-up of all Vendor-supplied equipment. Names and qualifications of the technicians proposed by Vendor for start-up advisory assistance shall be submitted for review by the Engineer.

All technicians participating in the plant start-up shall remain available or be replaced, as necessary for further assistance to the Owner after start-up.

WESTERN SYNCOAL

CENTER SYNCOAL FACILITY

GUIDE DESIGN BASES No. DB-07

Thermal Insulation

REV.	DATE	BY	CHK	APPROVAL	DESCRIPTION
0	10/23/96	JSC		RWS	Issued For Bid Purposes

INDEX

1.0 SCOPE

This Guide Design Bases covers the requirements for the supply and installation of thermal insulation materials for pipes, ductwork, flues, tanks and other equipments.

The Insulation Contractor's scope of work shall include, but is not limited to the items indicated in Section 1.1 which follows, but specifically excludes work listed in Section 2.0 of this Guide Design Bases.

1.1 Work Scope

Furnish all materials such as thermal insulation, insulation bonding materials, attachments and accessories as needed for insulating equipment and ductwork.

Provide all labor and services for the proper preparation, application and installation of all insulation.

Furnish all necessary tools and equipment in order to facilitate application and installation of all insulation which should include, but is not limited to the following:

- All safety, fire and ventilation equipment for use and protection of personnel.
- Scaffolding, temporary structures, ladders, tarpaulins, blowers, etc. for access to the work and protection of the installation personnel for direct sunlight, dust, moisture and other climatic conditions.

1.2 Alternate Quotations

Alternate quotations may be considered in the event the Insulation Contractor is not in agreement with any portion of this Guide Design Bases. However, Insulation Contractor must submit a basic quotation completely in accordance with all the terms and conditions set forth herein. Alternates will be considered only as separate items and must be submitted in the same form called herein.

2.0 WORK EXCLUDED

- Equipment, ductwork and pipe to be insulated.
- Service platforms, walkways and stairs
- Sleeves and inspection doors

3.0 CODES AND STANDARDS

Except where otherwise noted, insulation materials and their installations shall conform to the latest codes, standards and regulations listed below:

ASTM	-	American Society for Testing and Materials
TIMA	-	Thermal Insulation Manufacturer Association
NFPA	-	National Fire Protection Association
NICA	-	National Insulation Contractors Association
OSHA	-	Occupational Safety and Health Administration
UL	-	Underwriters Laboratory

In addition, applicable Federal, State, and Local Regulations, Codes and Ordinances must be complied with. If conflict exists between any of these codes and standards, the most stringent shall apply.

4.0 INSULATION REQUIREMENTS

Insulation products, methods and installation are subject to Owner's and Engineer's approval prior to start of work. Engineer must approve all products and substitutions.

Insulation shall not be applied to pipes or equipment until after the completion of pressure testing. If insulation is applied before testing, all welded and screwed connections shall be left exposed until testing is completed.

Insulation is applied for the following purposes:

Personnel Protection:

Piping, tanks, ductwork, flues, or other equipment above 140°F, where personnel may come in contact with hot surfaces, shall be insulated.

Anti-sweat Control:

Cold piping installed in warm humid areas, where sweating cannot be tolerated, shall be insulated.

Heat and Cold Conservation:

Equipment, ductwork, flues and piping handling steam, condensate, process and other fluids which are necessary to maintain proper operating temperature shall be insulated both indoors and outdoors to conserve heat/cold.

5.0 INSULATION MATERIALS

5.1 General

Insulation materials shall be asbestos-free, highly effective as non-conductors and be capable of withstanding the maximum temperature specified. Where Insulation Contractor states the thermal conductivity of insulating materials, the applicable unit (i.e. BTU/hr ft °F) and the corresponding mean temperature must be clearly stated.

The insulation thickness shall conform to item 6.0.

5.2 Operating Temperature

0 °F to 500 °F:

Fiberglass Insulation, with jacketing and vapor barriers.

The fiberglass shall be felted and banded together with controlled amount of organic binder. The insulation shall perform satisfactorily up to a temperature of 500 °F without deterioration of the bonding agent.

- Material for equipment and ductwork:

  Semi rigid board type fiberglass insulation with maximum thermal conductivity of 0.24 BTU/hr ft °F at 300 °F and density of 3.75 lb/ft^3

- Material for piping (diameter up to 14"):

  Preformed pipe type fiberglass insulation with maximum thermal conductivity of 0.025 BTU/hr ft °F at 300 °F and density of 3.75 lb/ft³

- Material for piping (diameter 16" and over):

  Fiberglass wool blanket insulation with maximum thermal conductivity of 0.025 BTU/hr ft °F at 300 °F and density of 3.75 lb/ft³

500 °F to 650 °F

Mineral wool (rock) insulation with jacketing and vapor barriers.

The mineral wool insulation shall perform satisfactorily up to 650 °F without deterioration of bonding agent.

- Materials for equipments, and ductwork with outside dimension up to 36" and piping with diameter over 14":

  Mineral wool blanket insulation with maximum thermal conductivity of 0.025 BTU/hr ft °F at 212°F and density of 4.00 lb/ft³

- Materials for equipment and ductwork (outside dimension of 36" and over):

  Mineral wool blanket insulation with wire with maximum thermal conductivity of 0.025 BTU/hr ft °F at 212 °F and density of 4.00 lb/ft³

- Materials for piping (diameter up to 12"):

  Preformed divided pipe type mineral wool (rock) insulation maximum thermal conductivity of 0.025 BTU/hr ft °F at 212 °F and density of 4.00 lb/ft³

650 °F to 1200 °F

Mineral wool (rock) insulation with insulation jacketing and vapor barriers.

The mineral wool insulation shall perform satisfactorily up to 1200°F without deterioration of bonding agents.

- Materials for equipment and ductwork:

  Board type mineral wool insulation with maximum thermal conductivity of 0.035 BTU/hr ft °F at 575 °F and density of 8 lb/ft³

- Materials for piping:

  Preformed divided pipe type mineral wool (rock) insulation maximum thermal conductivity of 0.034 BTU/hr ft °F at 575°F and density of 4.00 lb/ft³

5.3 Underground Piping

All underground piping insulations and finish shall be of FOAMGLASS system of Pittsburgh Corning Corporation or equivalent. Application, finish and accessory material for use with FOAMGLASS insulation on underground piping shall be in accordance with the recommendation of the manufacturer.

5.4 Flues

All flues with service temperature range of 250°F to 840°F shall be insulated with an asbestos free mineral fiber board (5 lb/cu ft). Small diameter ducts 12 inches and under shall be insulated with mineral fiber blanket (1.25 lb/cu ft).

Insulation thickness shall be 4" applied in one layer. Insulation shall be secured on the flues using 12 gauge welded steel pins and speed clips.

For insulation jacketing see item 5.6.

5.5 Vapor Barriers for Thermal Insulation

140°F to 1200°F: One layer of 50 pound virgin kraft paper coated on one side with 25 micron polyethylene film.

5.6 Insulation Jacketing

All equipments, piping and ductworks in an indoor or outdoor environment shall be provided with insulation jacketing material of 24 gage thickness type 304 stainless steel sheet metal.

- All piping:
  Standard mill finished flat.

- Equipment and ductwork:
  Standard mill finished flat.

All jacket joints shall overlap and be sealed with joint sealant. Joint sealant shall be non-shrinking, permanently flexible for dual application at low and high temperature stainless steel jackets.

Provide expander type bands as required for all hot tank and equipment.

Band for securing the metal jacketing shall be stainless steel. Minimum size of bands shall be 3/4 inch x 25 gage thick.

Metal studs or clips, if used, shall be compatible to the material of construction of the equipment and ducting to which they are attached.

Any holes or voids in the insulation jacketing shall be filled with mastic compound material selected by Vendor and conform to ASTM-C-647.

INSULATION THICKNESS

Service or Conditions	Operating Temp Range °F	Nominal Pipe Size				Tanks, Equipment, Ductwork
		1/2"-2"	2-1/2"-6"	8"-12"	Over 12"	
Refrigerant	0 - 40	1-1/2"	2"	2"	2-1/2"	2-1/2"
Chilled Water	40-50	1-1/2"	1-1/2"	2"	2-1/2"	2-1/2"
Anti-Sweat	55 - 90	1"	1"	1-1/2"	2"	2-1/2"
Personnel Protection	140 - 445	1"	1-1/2"	1-1/2"	2"	2"
Personnel Protection	445 - 645	2"	2-1/2"	3"	4"	4"
Heat Conservation	195 - 445	1-1/2"	2"	2"	2-1/2"	2-1/2"

7.0 INSULATION INSTALLATION

7.1 General

The requirements of Section 1.1 of this Guide Design Bases shall be complied with prior to the application of any work performed by the Vendor at the job site.

Equipment, piping and ducting shall be free of dirt, oil, scale or any foreign matter and shall be dry before insulation is applied.

All insulation subject to deterioration by water shall be kept dry before and after application.

7.2 Insulation Application and Attachments

All straight runs shall be insulated first, applying the jacketed insulation as near to valves, in-line instruments and fittings as possible. Then insulation and jacketing shall be applied to fit around the in-line instruments, valves and fittings. Finally, jacketing joints shall be sealed. Insulation around in-line instruments and valves shall be easily removable for check out and maintenance.

Insulation applied to external surfaces of equipment, piping and ducting shall form a continuous smooth surface and shall be applied around and over all reinforcing members. If more than one layer of insulation is applied, joints shall be arranged in staggered positions. Voids and irregular configurations and shapes of equipment and ducting shall be filled with compatible loose insulation material prior to weather proofing.

Insulation shall be applied and connected to equipment and ducting by means of the following attachments:

- Insulation shall be impaled over studs of No. 10 gage minimum size wire one inch longer than the insulation thickness.

- Insulation studs shall be gun-welded at 12 inch centers in horizontal and vertical directions. to all flat metallic surfaces that receive insulation. The insulation studs shall be spaced no more than 3 inches from insulation edges.
- Insulation studs that are gun-welded to cylindrical metallic surfaces greater than 140 inches in diameter. shall be spaced at 18 inch centers in both horizontal and vertical directions and positioned no further than 3 inches from the insulation edges.
- In addition to studs. insulation applied to cylindrical surfaces shall be banded with 3/4 inch wide x 25 gage thick stainless bands or Owner approved equal. and shall be placed at 24 inch centers. The steel bands shall be applied over the insulation. in such a manner. to avoid compressing the insulation.
- All insulation shall be impaled over the studs with extreme care. The insulation shall be free of tears and damage and be tightly butted over staggered joints. The second layer of insulation shall overlap the joints of the first layer by a minimum of three (3) insulation material thicknesses.
- Speed clip washers shall be placed over studs to hold the insulation against steel plate surfaces.

7.3 Heat Traced Insulation

In cases where thermal heating cable or tracers are helically wound on the process lines. oversize insulation shall be used where necessary. Heat tracing shall be provided as indicated on drawings. It is the Insulation Contractor's responsibility to provide tight insulation over tracing.

7.4 Cradle Supports

Equipment and ducting supported on metal cradle type supports. shall be provided with insulation that will be carried down over the cradles to the concrete or steel supporting structures with provision for thermal expansion. as applicable.

All metal parts such as lugs or stiffeners. which are an integral part of equipment and ducting, shall be fully insulated.

7.5 Insulation Sleeves

On hot or cold piping where special sleeves have been provided in walls. floors and ceilings. covering and jacketing shall run through sleeves with no breaks or joints.

7.6 Termination of Insulation

Termination of insulation shall be performed by cutting the covering. and coating the exposed material with heat resistant sealer. Jackets shall be brought up to. but not carried over. the cut edges.

On flanged connections. adjacent straight section insulation shall be terminated far enough away from flanges to permit bolt removal without damaging the insulation.

Removable section or "soft pad" insulation and weather-proof jacketing shall be provided over flanges at pump connections to facilitate removal and re-installation of pumps.

Pipe insulation shall be terminated as close as possible to uninsulated traps and strainers.

7.7 Flashing

Complete flashing is required on all outdoor applications.

A seal shall be made at all projecting brackets, hangers, supports, etc., using mastic or caulking gun grade 1 component gray polysulfide and/or epoxy based sealing compound, "Sonolast One-Part" as manufactured by Sonneborn Building Products, or approved equal.

The mastic shall be non-sagging, non-flowing, nonstaining and resistant to water, while maintaining elasticity and positive adhesion to all materials.

7.8 Underground Piping

After underground pipe sections have been installed and the system has been tested, pipe and fittings shall be insulated and jacketed, in accordance with paragraph 5.6 and 6.0.

7.9 Fittings Insulation

Fittings, valves and accessory items which require insulation shall be covered as listed in the table below unless otherwise noted:

Item	Temperature 140-120°F	Traced Lines
Elbows	Insulate	Insulate
Tees	Insulate	Insulate
Reducers	Insulate	Insulate
Valves*	Insulate	Insulate
Unions	Insulate	Insulate
Flanges	Insulate	Insulate
Vic Couplings	Insulate	Insulate
Traps	No	No
Strainers	No	No

* Valve body and bonnets only.

7.10 Tank, Bin, Hoppers and Other Equipment

The outside surfaces of tanks and other equipment shall be free of all oil, grease, dirt, scale, and foreign matter and be dry before insulation is applied.

All vertical equipment will have 3 inch wide insulation support rings already installed. Equipment with straight side height exceeding 8 feet also will have a support ring located at maximum 12 feet intervals. Insulation Contractor shall apply the self supporting board type insulation to the equipment in accordance to industry wide accepted practices prior to installing the outer stainless steel sheet metal. The Insulation Contractor shall obtain Engineer's written approval of fastener method.

All metal attachments which protrude through the insulation, including insulation branch connections, pipe supports and hangers, shall be insulated for a distance of at least four times the insulation thickness.

When equipment is
cradles to the concre
applicable.

All metal parts such
insulated.

The Insulation Cont
rubber lined vessel c

Nameplates, coding
the nameplate, codin

11.0 ATTACHMENTS

The following documents are a part of this Guide Design Bases:

Guide Design Bases DB-01, Standard Technical and Site Data

APPENDIX B-3

DRYER AND REACTOR SPECIFICATIONS

Fluidized Bed Coal Dryer/Reactor System
Technical Specification: LS-685-011

Introduction:

The fluidized bed coal dryer and reactor systems and associated equipment as specified herein and shown on piping and instrument diagrams, Drawings 07063.01-DJ-120-A and 07063.01-DJ-125-A, and the related mass & energy balance are to be supplied by Carrier Vibrating Equipment, Inc. as noted herein for the Center SynCoal Facility Project. Carrier shall incorporate its prior test work as a basis into this specification.

A SynCoal® processing facility is currently proposed for installation at the Minnkota Power Cooperative Milton R. Young Power Station in Center, North Dakota. The SynCoal® facility will process locally mined lignite coal for supply of an upgraded coal product for fuel to the power plant. The project design incorporates lignite processing units (two units arranged in series, and referred to as Dryer and Reactor, respectively) of a static fluid bed configuration. Associated with the fluid bed units are cyclone systems for recovery of solids entrained from the fluidized beds into the fluidizing gas. The project design is based on equal sizing of the Dryer and Reactor units. Heating of the fluidizing gas shall be by external heat exchangers, provided by others.

Scope:

The bidder shall provide all mechanical equipment and motors for the fluid bed system as described herein:

Contractor shall furnish two (2) conventional (non-vibratory) fluidized bed coal Dryer/Reactor systems complete with auxiliary components as listed herein, adequately sized to meet the criteria set forth in the process parameters section of this specification. The systems shall consist of the equipment depicted by Piping and Instrumentation Drawings 07063.01-DJ-120-A and 07063.01-DJ-125-A, and Carrier Drawings Rosebud 2 and FK 19333001-A, including but not limited to:

DRYER SYSTEM COMPONENTS

A. One (1) conventional (non-vibratory) fluid bed unit, Model C-FBD-12'-0" x 26'-0"-1/4" (m/s), 12'-0" wide by 26'-0" long by 38'-0" tall, consisting of:

1. Plenum fabricated of 1/4" mild steel with internal refractory insulation.
2. Upper casing fabricated of 1/4" mild steel, expanded in cross section 100%, and with (2) internal baffles.
3. Directional mild steel distribution deck, 3/16" thick, with 3/16" diameter holes on a 1/2" x 1/2" staggered spacing (subject to final design).
4. Slumped bed depth = 14"

5. Fluidized bed depth = 24"
6. Bed area = 312 ft
7. Two (2) 24" x 24" inlets with abrasion resistant liners and spreader gates.
8. Two (2) 16" x 16" outlets with pneumatic actuated underflow gates and abrasion resistant liners.
9. Instrumentation nozzles.
10. Emergency deluge fire suppression system piping, headers and nozzles.
11. Start-up spray system piping, headers and nozzles.
12. Structural design for +4 psig overpressure and -1 psig underpressure.

B. Two (2) quad arrangements of cyclone dust collectors fabricated of 1/4" thick mild steel complete with common inlet manifolds, common outlet manifolds, and dual dust receivers. The cyclone collection fractional efficiency shall be as defined in Table 1. The cyclone underflow will discharge particulate through a double-dump valve to Reactor inlet, using a chute at an angle not less than 65 degrees from horizontal. The double dump valve will be supplied by others.

Table 1
Fisher-Klosterman XQ465-39.0000 Cyclone Guaranted Minimum Efficiency

Particulate Size (microns)	Collection Efficiency (%)
2.50	6.68
3.00	13.04
3.50	19.97
4.00	27.12
4.50	34.29
5.00	41.19
5.50	47.66
6.00	53.60
6.50	58.98
7.50	68.10
8.50	75.25
10.00	83.02
12.00	89.10
14.00	92.67
19.00	96.64
39.00	99.43

C 1/4" thick mild steel ductwork between the fluid bed exhaust spouts and the cyclone inlets complete with support saddles and brackets. Sixteen (16) sets of flanges (4 in each vertical exhaust duct) for mounting of 24" x 30" deflagration relief panels are included, as defined on Engineered Machine Product's drawings 97A-0221-1 and 97A-0221-2.

D. 1/4" thick, mild steel cyclone outlet transitions.

E. Stainless steel flexible metal bellows expansion joints with stainless steel internal liners. Expansion joints to be located as follows:

- Four (4) 72" diameter at the fluid bed gas inlets.
- Four (4) 52" diameter at the fluid bed gas outlets.
- Four (4) 52" diameter at the cyclone gas upper inlets.
- Two (2) 24" diameter at the fluid bed material inlets.
- Two (2) 24" diameter at the fluid bed material outlets.
- Four (4) 18" diameter at the cyclone fines outlets.
- Two (2) 18" diameter at the fines chute outlets.

F. Material chutes

- Two (2) 1/4" thick mild steel inlet adapters from 16" x 16" to 24" diameter.
- Two (2) 1/4" thick mild steel outlet adapters from 24" diameter to 24" x 24"
- Two (2) 16" x 16" 1/4" abrasion resistant chutes from the dryer outlet flanges to the reactor inlet double dump valves.
- A set of 12" diameter abrasion resistant chutes from the cyclone fines discharge to the reactor bed inlet.

G. Other mechanical equipment as required for normal operation and maintenance.

H. Approximate weights

Fluid bed unit without refractory insulation	90,000 lbs
Refractory insulation	20,000 lbs
Cyclones (two quads)	46,000 lbs

REACTOR SYSTEM COMPONENTS

I One (1) conventional (non-vibratory) fluid bed unit, Model C-FBD-12'-0" x 26'-0"-1/4" (m/s), 12'-0" wide by 26'-0" long by 38'-0" tall, consisting of:

- Plenum fabricated of 1/4" mild steel with internal refractory insulation.
- Upper casing fabricated of 1/4" mild steel, expanded in cross section 100%, and with (2) internal baffles.
- Directional mild steel distribution deck, 3/16" thick, with 3/16" diameter holes on a 1/2" x 1/2" staggered spacing (subject to final design).
- Slumped bed depth = 14"
- Fluidized bed depth = 24"
- Bed area = 312 ft

- Two (2) 24" x 24" inlets with abrasion resistant liners and spreader gates.
- Two (2) 16" x 16" outlets with pneumatic actuated underflow gates, abrasion resistant liners, and a manually adjusted diverter gate, allowing adjustment from 50/50 to 0 to 100 ratio splits between discharge chute legs.
- Instrumentation nozzles.
- Emergency deluge fire suppression system piping, headers and nozzles.
- Start-up spray system piping, headers and nozzles.
- Structural design for +4 psig overpressure and -1 psig underpressure.

J. Two (2) quad arrangements of cyclone dust collectors fabricated of 1/4" thick mild steel complete with common inlet manifolds, common outlet manifolds and dual dust receivers. The cyclone collection fractional efficiency shall be as defined in Table 2. The cyclone underflow will discharge particulate through a double-dump valve to Reactor outlet above the manually adjusted diverter gate, using a chute at an angle not less than 65 degrees from horizontal. The double dump valve will be supplied by others.

Table 2
Fisher-Klosterman XQ465-39.0000 Cyclone Guaranted Minimum Efficiency

Particulate Size (microns)	Collection Efficiency (%)
2.50	6.20
3.00	12.64
3.50	19.26
4.00	25.93
4.50	32.63
5.00	39.13
5.50	45.28
6.00	50.99
6.50	56.21
7.50	65.20
8.50	72.42
11.00	84.25
13.00	89.43
15.00	92.62
20.00	96.27
35.00	98.85

K. 1/4" thick mild steel ductwork between the fluid bed exhaust spouts and the cyclone inlets complete with support saddles and brackets. Sixteen (16) sets of flanges (4 in each vertical exhaust duct) for mounting of 24" x 30" deflagration relief panels are included, as defined on Engineered Machine Product's drawings 97A-0221-1 and 97A-0221-2.

L. 1/4" thick, mild steel cyclone outlet transitions.

M. Stainless steel flexible metal bellows expansion joints with stainless steel internal liners. Expansion joints to be located as follows:

- Four (4) 72" diameter at the fluid bed gas inlets.
- Four (4) 52" diameter at the fluid bed gas outlets.
- Four (4) 52" diameter at the cyclone gas upper inlets.
- Two (2) 24" diameter at the fluid bed material inlets.
- Two (2) 24" diameter at the fluid bed material outlets.
- Four (4) 18" diameter at the cyclone fines outlets.
- Two (2) 18" diameter at the cyclone fines chute outlets.

N. Material chutes

- Two (2) 1/4" thick mild steel inlet adapters from 16" x 16" to 24" diameter.
- Two (2) 1/4" thick mild steel outlet adapters from 24" diameter to 24" x 24"
- Two (2) 16" x 16" 1/4" thick abrasion resistant chutes from the dryer outlet flanges to the reactor inlet double dump valves.
- A set of 12" diameter abrasion resistant chutes from the cyclone fines discharge to the reactor bed inlet.

O. Other mechanical equipment as required for normal operation and maintenance

P. Approximate weights

Fluid bed unit without refractory insulation	90,000 lbs
Refractory insulation	20,000 lbs
Cyclones (two quads)	46,000 lbs

Fluidized Bed System Process Parameters and Design Data:

Feed material:	Lignite coal	
Design Nominal Feed Rate:	100 TPH	
Feed material size distribution:	nominal 3/4" x 0"	
	maximum 5% > 3/4 inch	
	maximum 5% < 20 mesh	
Dryer feed material quality:	Design	Expected Range
Moisture (wt %)	36.0	35.0 - 39.0
Ash (wt %)	8.2	3.8 - 16.0
HHV (Btu/lb)	6620	5730 - 7060
Sodium (wt %)	5.0	1.0 - 12.1
Feed material temperature range:	33 °F to 70 °F	

Feed material bulk density:	45-50 lb/ft^3 wet
Material specific heat:	
@ -40°F to 220°F	0.29 Btu/lb°F
@ 220°F to 550°F	0.32 Btu/lb°F
Specific gravity:	nominal 1.4
	range 1.3 to 5.0
Dryer outlet/Reactor inlet temperature:	230°F
Dryer outlet/Reactor inlet moisture:	21% (wet basis)
Reactor product:	SynCoal®
Reactor product rate:	65.3 tph
Reactor outlet product temperature:	450°F
Reactor outlet product size distribution:	as defined by Carrier testing
Reactor product moisture:	2% (wet basis)
Reactor product bulk density:	38-42 lb/ft^3
Dryer heat load:	~ 69 mm BTU/hr
Reactor heat load:	~ 49 mm BTU/hr
Process gas supply temperature:	
Dryer	550°F (superheated recycle gas)
Reactor	750°F (superheated recycle gas)
Volatiles:	Water and misc. small quantities of hydrocarbons
Site altitude:	1960 FASL
Design ambient temperatures:	-40°F to 110°F
Available startup spray process water:	150 gpm @ 40 psig at 2090 FASL
Available fire protection water:	160 gpm @ 25-65 psig at 2105 FASL

Fluid Bed Dryer/Reactor Construction:

The fluid bed units will be constructed with pyramidal hoppers with opposing fluidizing gas inlet nozzles oriented per Engineer's GA requirements. This will allow some drop-out of material entrained in the gas flow before it reaches the fluid bed. The hopper bottoms will have a flanged bolt arrangement to match a 10" x 10" Plattco dump valve. Since the pyramidal hoppers could potentially collect condensate after startup, water drains will also be provided.

The weirs on the discharge of the fluid beds are to manually adjustable in height during shutdown. The underflow weirs and gates for the fluid bed units will be pneumatically operated. Carrier is to supply any accumulators necessary.

The fluid bed sections that are being shipped separately will include all necessary erection clips to pull the pieces together for assembly. All field assembly work and welding is to be completed by the Contractor.

Insulation and Lagging Design:

Carrier shall supply an appropriate design for the insulation and lagging of the dryer, reactor, cyclones and all supplied chute work and ductwork. This design shall accommodate reasonable field installation requirements.

Insulating Refractory:

Carrier shall install high efficiency insulating refractory in the plenum of each of the Dryer and Reactor in the field. The refractory shall be of a gunned type, appropriate for the design conditions.

Chutework Construction:

All chutes will be fabricated using abrasion resistant steel. Chutework joints shall be flanged and bolted. Carrier shall supply all required fasteners and gaskets.

Ductwork Joints:

Ductwork joints shall be welded.

Expansion Joint Materials and Orientation:

Where possible expansion joints shall be oriented vertically. Expansion joint material to be defined by Engineer. All expansion joint connections shall be welded.

Startup Sprays:

Each fluid bed unit shall be supplied with a startup water spray system. Water sprays are to provide a substitute heat load for equipment startup. Each spray header system shall be designed to supply atomized water for a range of flow rates. For the Dryer the range is 20 to 80 gpm, and for the Reactor 15 to 60 gpm (representing approximately 15 to 50% of normal head load). Water spray shall occur evenly over entire bed surface area. Water source shall be coarse filtered process water.

Fire Suppression Deluge System:

Each fluid bed unit shall be supplied with a water deluge system. Each deluge system shall supply a minimum of 0.5 gpm/ft^2 of fluidized bed surface area. Source of water shall be the fire protection system. Water header and sprays are to be designed so that all portions of the upper surface of the slumped bed of solids are exposed to equal amounts of water.

Manways and Cleanouts:

Manways and cleanouts to allow for adequate maintenance and cleaning of equipment will be provided above the deck. Purchaser shall supply manways in the inlet duct.

Equipment Arrangement:

Carrier shall work closely with the Engineer to develop an equipment and ductwork layout that ensures no interferences with structural or other equipment. The locations of ductwork need to suit the beam and column locations as designed by the Engineer. Carrier will supply shoes and brackets for the ductwork within its scope of supply.

Instrumentation Nozzles:

Instrumentation nozzles will be 2" flanged nozzles inclined down at 45 degrees, with a flange bolting pattern oriented per Engineer drawing.

Instrumentation:

Instrumentation shall be supplied by others. Carrier shall provide Carrier recommended instrumentation data sheets which conform to Purchaser approved instrumentation list.

System Information:

Carrier shall provide all applicable technical information including but not limited to:

A. Inlet gas characteristics for each fluid bed unit including but not limited to:
  - Temperature (°F)
  - Pressure (psia)
  - Volumetric flow rate (acfm and scfm)

B. Outlet gas characteristics from each fluid bed unit including but not limited to:
  - Temperature (°F)
  - Particulate loading (grains per actual cubic foot)
  - Pressure (psia)
  - Volumetric flow rate (acfm and scfm)

C. Outlet gas characteristics from each cyclone system including but not limited to:
  - Temperature (°F)

- Particulate loading (grains per actual cubic foot)
- Pressure (psia)

D. System pressure differentials versus volumetric flow rate including but not limited to:

- Each fluid bed distribution plate pressure loss
- Each expanded bed pressure loss
- Each unit's hood to cyclone inlet pressure loss
- Each unit's cyclone assembly pressure loss from inlet to outlet

E. Slumped and expanded bed depths and freeboard area
F. Fluidized bed gas superficial velocity
G. Fluid bed dimensions
H. Cyclone dimensions and model numbers
I. Cyclone particulate removal efficiency
J. Approximate weights of major components
K. Description of recommended instrumentation
L. Maximum allowable loads on the following nozzles:

- Fluidizing gas inlet nozzles
- SynCoal® outlet from Reactor nozzle
- SynCoal® outlet from Reactor cyclone hopper chutework tie point
- Dryer cyclone fluidizing gas outlet
- Reactor cyclone fluidizing gas outlet
- Coal inlet to Dryer

M. Recommended spare parts

EQUIPMENT AND/OR SERVICES BY OTHERS

- Structural steel
- Foundations
- Process gas ductwork between the cyclone exhaust transitions and the recirculating fan for each fluid bed unit.
- The recirculating fans for each fluid bed unit including inlet and outlet transitions and expansion joints.
- Process gas ductwork between the recirculating fan outlet and the fluid bed gas inlet expansion joint (4 at 72" diameter) for each fluid bed unit.
- Process gas heat exchangers.
- Field assembly and installation of proposed equipment.
- Field wiring (instrument and power).

- Field piping.
- Motor controls (starters, start/stop pushbuttons, etc.)
- Plant control systems.
- Field insulation and lagging (designed by Carrier) of all equipment (minimum 3" thick insulation on everything except the fluid bed unit plenums, 1" thick insulation on the fluid bed unit plenums) and over all external stiffeners.
- Material feed equipment.
- Material takeaway equipment including chute work after the reactor material outlet expansion joints.
- 1000 F superheated 2400 psig steam supply.
- 460 volt, 3 phase, 60 Hertz electrical supply.
- 4,160 volt, 3 phase, 60 Hertz electrical supply.
- 100 psig compressed air.
- 120 volt, single phase, 60 Hertz control voltage supply.
- Instrumentation.
- Double dump valves.

ATTACHMENTS

- *Stone & Webster Drawing 07063.01-DJ-120-A*
- Stone & Webster Drawing 07063.01-DJ-125-A
- Stone & Webster Mass & Energy Balance
- Carrier Drawing Rosebud 2
- Fisher-Klosterman Drawing FK 19333001-A
- Engineered Machine Products Drawing 97A-0221-1, 2/21/97

x Engineered Machine Products Drawing 97A-0221-2, 2/21/97

APPENDIX B-4

COOLER SPECIFICATION

Roto-Fin Thru-Tube Type Cooler
Technical Specification: LS-685-030

Introduction:

The Roto-Fin thru-tube solid material coolers and associated equipment as specified herein and shown on piping and instrument diagram, Drawing 07063.01-DJ-130-A and the related mass & energy balance are to be supplied by FMC Corporation as noted herein for the Center SynCoal Facility Project.

A SynCoal® processing facility is currently proposed for installation at the Minnkota Power Cooperative Milton R. Young Power Station in Center, North Dakota. The SynCoal® facility will process locally mined lignite coal for supply of an upgraded coal product for fuel to the power plant. The project design incorporates two (2) Roto-Fin coolers arranged in parallel to cool the hot processed lignite (SynCoal) in an inert atmosphere to be provided by FMC. The cooling water circulation and heat rejection systems will be provided by others.

Scope:

The bidder shall provide all mechanical equipment and motors for the Roto-Fin cooler as described herein:

FMC shall furnish two (2) Model 900RT30 Roto-Fin Thru-Tube Coolers complete with auxiliary components as listed herein, adequately sized to meet the criteria set forth in the process parameters section of this specification and Guide Design Bases DB-11 and DB-16B. The systems shall consist of the equipment depicted by Piping and Instrumentation Drawings 07063.01-DJ-130-A and FMC Drawings JK6689-1 and JK6689-2, including but not limited to:

A. Two (2) Model 900RT30 Coolers: each complete with cooling drum, water basin and cover, drive components, and support bases
B. Final drive arrangement shall be determined in coordination with the Engineer.
C. Flanged nozzles and connections for cooling water inlet and outlet, drains, purge/sweep gas (nitrogen)
D. Horizontal flanged nozzle connections for SynCoal• inlet and outlet
E. Instrument taps and fittings for monitoring process and cooling water temperatures, water level
F. Rotating seals and dust control shrouds
G. Certified design drawings in hard copy and AutoCad (Version 12 compatible) drawing file delivered to Engineer and Technical Representative
H. Installation instructions, operations and maintenance manuals
I. Complete parts list identifying recommended spare parts
J. All Purchaser approved spare parts for startup and commissioning
K. List and recommended supplier(s) for all special tools used for installation and maintenance

L. Paint matching manufacturer's standard for field touchup of FMC equipment

Cooler Operating Scenarios

Cooler design shall accommodate the following operating scenarios:

- Normal Operation
    - Cooler infeed at 33 TPH per cooler
    - Infeed temperature of 550°F
    - Outfeed temperature of 150°F
    - Infeed sizing

Size Fraction	Cum. % Retained
+ 3.5 mesh	0.0
+ 8 mesh	38.8
+ 50 mesh	92.4
+ 100 mesh	96.4

    - Infeed moisture content of 2%
    - Cooling water flow of 530 gpm per cooler

- Abnormal Operation #1
    - Cooler infeed at 65.3 TPH with only one cooler operating
    - Infeed temperature of 550°F
    - Outfeed temperature to be estimate by FMC
    - Infeed sizing

Size Fraction	Cum. % Retained
+ 3.5 mesh	0.0
+ 8 mesh	38.8
+ 50 mesh	92.4
+ 100 mesh	96.4

    - Infeed moisture content of 2%
    - Cooling water flow at maximum tank capacity

- Abnormal Operation #2
    - Cooler infeed at a minimum of 8 TPH per cooler
    - Infeed temperature of ≤ 150°F
    - Infeed sizing

Size Fraction	Cum. % Retained
+ 3/4 inch	2.0
+ 1/2 inch	20.0
+ ¼ inch	62.0

+ 0.05 inch	94.0

- Infeed moisture content of 20%

Cooler Process Parameters and Design Data:

Feed material:	Hot SynCoal
Design Nominal Feed Rate (total):	65.3 TPH
Feed material size distribution:	nominal 1/4" x 0"
	maximum 5% > 1/4 inch
	maximum 5% < 100 mesh

Typical Sizing

Size Fraction	Cum. % Retained
+ 3.5 mesh	0.0
+ 8 mesh	38.8
+ 50 mesh	92.4
+ 100 mesh	96.4

Feed material quality:	Design	Expected Range
Moisture (wt %)	2.0	0.5 - 18.0

Feed material temperature range:	150°F to 550°F
Feed material bulk density:	38-42 lb/ft^3
Material specific heat:	0.32 Btu/lb°F
Specific gravity:	nominal 1.4
	range 1.3 to 5.0

Cooler product:	Cooled SynCoal®
Cooler product rate:	65.3 tph
Cooler outlet product temperature:	≤ 150°F

Cooler heat load (each): ~ 9.3 mm BTU/hr

Cooler operating temperatures (maximum)

SynCoal® inlet temperature:	550 °F
SynCoal® outlet temperature:	150 °F
Cooling water inlet temperature:	75 °F
Cooling water outlet temperature:	≤ 110 °F
Cooling water flowrate (total):	1060 gpm total (530 gpm/Cooler unit)

Cooler operating temperatures (nominal)

SynCoal® inlet temperature:	450 °F

SynCoal® outlet temperature:	Vendor to supply information (≤ 150 °F)
Cooling water inlet temperature:	75 °F
Cooling water outlet temperature:	Vendor to supply information (≤ 110 °F)
Cooling water flowrate (total):	Vendor to supply information (≤ 530 gpm/Cooler unit)

Site altitude:	1960 FASL
Design ambient temperatures:	-40°F to 110°F
Available fire protection water:	160 gpm @ 25-65 psig at 2105 FASL

Manways and Cleanouts:

Manways, cleanouts or alternatives acceptable to Purchaser shall be provided to allow for adequate maintenance and cleaning of equipment.

Equipment Arrangement:

FMC shall work closely with the Engineer to develop an equipment and piping layout that ensures no interferences with structural or other equipment. The locations of piping needed to suit the beam and column locations as designed by the Engineer. The overall cooling circuit for the cooling water includes a roof-mounted dry basin cooling tower, gravity flow piping to the Roto-Fin Coolers, gravity flow piping from the Coolers (via overflow weir) to a surge tank feeding the cooling water recirculation pumps and return piping to the cooling tower.

Instrumentation Nozzles:

Instrumentation nozzles will be 2" flanged nozzles inclined down at 45 degrees, with a flange bolting pattern oriented per Engineer drawing.

Instrumentation:

Instrumentation shall be supplied by others. FMC shall provide FMC recommended instrumentation data sheets which conform to Purchaser approved instrumentation list.

Nitrogen System:

Each Cooler shall be supplied with inerting nitrogen gas which as a minimum shall be used for 1) startup inerting; 2) gas volume to fill interstitial voids between the solid particles and to replace any steam condensed during the cooling process; 3) to replace any gas outleakages and vents; 4) seal purges; and 5) for fire protection. Item 2 is estimated to require approximately 3000 to 5000 CFH of nitrogen (total). Nitrogen requirements for the other services will be addressed during detailed design.

System Seals:

System seals shall be designed to operate at 1 inch wc with no more that 1 scfh nitrogen loss.

Drains and Cleanouts:

Drains, cleanouts and access ports shall allow for adequate maintenance and cleaning of equipment.

Materials of Construction:

All chutes will be fabricated using abrasion resistant steel. Replaceable AR wear plates shall be provided on chutework wear surfaces. Chutework joints shall be flanged and bolted. FMC shall supply all required fasteners and gaskets. Typical material of construction for Cooler system shall be carbon steel.

Vendor Information:

FMC shall provide all applicable technical information including but not limited to:

A. Drawings and descriptive data
B. Approximate weights of major components and support locations
C. Description of recommended instrumentation
D. Maximum allowable loads on the following flanges:
   - Cooler SynCoal* inlet flange
   - Cooler SynCoal* outlet flange
   - Water inlet and outlet flanges
   - Inerting gas inlet and outlet flanges
E. Recommended spare parts and projected replacement schedule
F. Seal specification for purge nitrogen (delivery pressure required, seal operating pressure, nitrogen volume required)
G. Nitrogen purge gas loss through rotary joints

Equipment and / or Services By Others

- *Equipment unloading, storage, and field erection*
- Chutework between Cooler inlet flange and upstream equipment, including expansion joint(s) and valve(s) as appropriate
- Chutework from Cooler outlet flange to downstream equipment, including expansion joint(s) and valve(s) as appropriate

- Cooling water supply, including piping, pumps and valves
- Inert purge/sweep gas (nitrogen) as required
- Foundations and structural supports, design and supply
- Walkways, stairways, ladders, platforms, and handrails
- Insulation and lagging as appropriate
- Instrumentation
- Plant control system
- Electrical interconnection and field wiring; 480 Volt, 3 Phase, 60 Hertz AC electrical power
- Field touchup painting of FMC supplied equipment
- Shipping
- Material feed equipment
- Material takeaway equipment including chute work after the reactor material outlet expansion joints
- Double dump valves

Attachments

- Stone & Webster Drawing 07063.01-DJ-130-A
- Stone & Webster Mass & Energy Balance
- Guide Design Basis: DB-11 for Engineered Equipment
- Guide Design Basis: DB-16B for Electric Motors
- FMC Drawing JK6689-1
- FMC Drawing JK6689-2

APPENDIX B-5

SYNCOAL® FEED SYSTEM SPECIFICATION

COPY

STONE & WEBSTER ENGINEERING CORPORATION

GSWebster
RMHouston
MJLidinsky
GRTodd
Project File
SW/WS-001

Letter No. SW/WS-001

February 10, 1997

J.O. No. 07063.02

Smoot Co.
1250 Seminary
Kansas City, Kansas 66103

Attn: Mark W. Rhoads

PNEUMATIC CONVEYOR SYSTEM
CENTER SYNCOAL FACILITY
WESTERN SYNCOAL COMPANY

Enclosed are the following documents for your use in preparing a pneumatic conveyor bid package:

- Definition and Performance Specification
- January 28 & 29, 1997 Meeting Notes
- Stone & Webster Sketches
  - 07063.02-SK-2-1
  - 07063.02-SK-8-1
  - 07063.01-SK-3B
- Programmable Logic Control System Specification
- Electric Motor Specification
- Motor Data Sheet
- Jenike & Johanson, Inc. Package

Please contact us if you have any questions or comments.

G.S. Webster
Project Engineer

GSW:RMH:RAK

COPY

STONE & WEBSTER ENGINEERING CORPORATION

GSWebster
RMHouston
MJLidinsky
GRTodd
Project File
SW/WS-001

Letter No. SW/WS-001

February 10, 1997

J.O. No. 07063.02

Delta Ducon
40 Lloyd Avenue
Malvern, PA 19355-3020

Attn: Leonard E. Potts, Jr.

PNEUMATIC CONVEYOR SYSTEM
CENTER SYNCOAL FACILITY
<u>WESTERN SYNCOAL COMPANY</u>

Enclosed are the following documents for your use in preparing a pneumatic conveyor bid package:

- Definition and Performance Specification
- January 28 & 29, 1997 Meeting Notes
- Stone & Webster Sketches
  - 07063.02-SK-2-1
  - 07063.02-SK-8-1
  - 07063.01-SK-3B
- Programmable Logic Control System Specification
- Electric Motor Specification
- Motor Data Sheet
- Jenike & Johanson, Inc. Package

Please contact us if you have any questions or comments.

G.S. Webster
Project Engineer

GSW:RMH:RAK

COPY

STONE & WEBSTER ENGINEERING CORPORATION

GSWebster
RMHouston
MJLidinsky
GRTodd
Project File
SW/WS-001

Letter No. SW/WS-001 — February 10, 1997

J.O. No. 07063.02

Air Cure Incorporated
5155 East River Road
Minneapolis, MN 55421

Attn: Michael R. Harris

PNEUMATIC CONVEYOR SYSTEM
CENTER SYNCOAL FACILITY
<u>WESTERN SYNCOAL COMPANY</u>

Enclosed are the following documents for your use in preparing a pneumatic conveyor bid package:

- Definition and Performance Specification
- January 28 & 29, 1997 Meeting Notes
- Stone & Webster Sketches
  - 07063.02-SK-2-1
  - 07063.02-SK-8-1
  - 07063.01-SK-3B
- Programmable Logic Control System Specification
- Electric Motor Specification
- Motor Data Sheet
- Jenike & Johanson, Inc. Package

Please contact us if you have any questions or comments.

G.S. Webster
Project Engineer

GSW:RMH:RAK

COPY

STONE & WEBSTER ENGINEERING CORPORATION

GSWebster
RMHouston
MJLidinsky
GRTodd
Project File
SW/WS-001

Letter No. SW/WS-001

February 10, 1997

J.O. No. 07063.02

Douglas Scientific
P.O. Box 3788
Littleton, CO 80161

Attn: Forrest Douglas

PNEUMATIC CONVEYOR SYSTEM
CENTER SYNCOAL FACILITY
<u>WESTERN SYNCOAL COMPANY</u>

Enclosed are the following documents for your use in preparing a pneumatic conveyor bid package:

- Definition and Performance Specification
- January 28 & 29, 1997 Meeting Notes
- Stone & Webster Sketches
  - 07063.02-SK-2-1
  - 07063.02-SK-8-1
  - 07063.01-SK-3B
- Information Drawings (1 roll)
- Programmable Logic Control System Specification
- Electric Motor Specification
- Motor Data Sheet
- Jenike & Johanson, Inc. Package

Please contact us if you have any questions or comments.

G.S. Webster
Project Engineer

GSW:RMH:RAK

Pneumatic Transport System for SynCoal®
Definition and Performance Specification - LS-685-010
Revision 1

Introduction

You are invited to propose on a pneumatic transport system and associated equipment. Included in or with this memorandum, for your use in developing a bid package, are: a system description; general site information; product and performance parameters; a project memorandum summarizing meeting notes from Vendor site visits; design criteria for motors and controls; and sketches of the conceptual plant layout and feed system. Scope and specification of the equipment and services to be included in your proposal is described below.

Description

SynCoal®, an upgraded fuel produced from lignite coal, will be produced at a new facility at Minnkota Power Cooperative's Milton R. Young Power Station which is located near Center, North Dakota. The SynCoal® will be added as a fuel supplement to existing lignite coal which feeds the Unit No.1 and Unit No. 2 boilers located at the power station. The equipment requested will be utilized to transport SynCoal® from a storage system to the boiler feed lines as described herein. Unit No. 1 utilizes seven (7) cyclone burners and Unit No. 2 utilizes twelve (12) cyclone burners in their respective boilers. Each burner uses approximately 35 tons per hour (tph) of lignite. It is anticipated that SynCoal® will normally make up about 10% of the total feed to a burner or about 3.5 tph. The SynCoal® facility will be located approximately 250 feet south of Unit No. 2. A sketch is attached (SWEC No. 07063.02- SK-3B) which shows approximate locations of the SynCoal® facility and Unit No. 1 and Unit No. 2 burners.

The SynCoal® facility will be designed to produce 67 tons per hour of SynCoal® based on an infeed lignite rate of 100 tons per hour. It is anticipated that during normal operations the SynCoal® will be evenly distributed between the nineteen (19) burners of the two (2) units, however, the ability to utilize all of the SynCoal® in Unit 2 shall be maintained as the minimum design.

As indicated on the plot plan sketch, two (2) SynCoal storage silos would be provided near the processing building. The silo for Unit No. 1 will have a capacity of 200 tons and the silo for Unit No. 2 will have a capacity of 350 tons. As indicated by the attached sketch (SWEC sketch 06891.01-SK-2-1), the primary transport system shall transfer SynCoal® from the storage silos to 22 ton surge bins near Unit No. 1 and Unit No. 2. The secondary transport system shall meter SynCoal® into each cyclone burner lignite feed system.

Due to the configuration of the burners it is anticipated that the primary transport system shall consist of three (3) pneumatic transport systems. One (1) pneumatic system would be required to feed two (2) surge bins for Unit No. 1 burners and two (2) systems would be required to feed four (4) surge bins for Unit No. 2 burners. Each primary transport system shall originate at approximately ground level (1960 FASL), travel vertically approximately 130 feet and then proceed horizontally to the boiler facility. Once inside the boiler facility, the transport lines shall be routed to the respective surge bins which shall be located near the cyclone burner lift lines. The three (3) systems shall be capable of simultaneous operation. Each system is anticipated to utilize dilute phase transport.

From the surge bins, SynCoal® will be metered into secondary transfer systems to carry the SynCoal® to each cyclone burner lignite feed system. The metering screw and airlock arrangement depicted by Drawing 06891,01-SK-2-1 was recommended by Jenike and Johanson, Inc. as the preferred arrangement. Metered SynCoal® is proposed to be pneumatically transferred to the burner fuel lift lines which operate at a positive pressure of approximately 20 in.wc. All nineteen (19) systems shall be capable of simultaneous, continuous operation. Each system as depicted would utilize dilute phase transport. Note that the prospect of gravity feed is also open to Vendor recommendations (see attached Unifield memorandum with meeting notes).

General Process Information:

1. Product: SynCoal®
2. Site altitude: 1960 FASL (13.7 psia pressure)
3. Ambient temperatures: -40°F to 110°F
4. Specific gravity: 1.4
5. Material density: 38-42 lb/ft^3
6. Approximate SynCoal® sizing:

+ 3.5 mesh	0.0%
+ 8 mesh	38.8%
+ 50 mesh	92.4%
+ 100 mesh	96.4%

Transport System Parameters:

1. Primary system capacity: 36 tph, each of 3 lines
2. Secondary system capacity: 0.9 to 5.2 cf/min (1 to 6 tph) each (Optional design case : 3 to 6 tph range of flow to each cyclone)
3. Lift line pressure: approximately 20 in.wc. (lignite lift line pressure at inject)
4. Secondary system accuracy: +/- 2% volumetric basis at maximum capacity (Optional design case : +/- 4% volumetric basis)
5. Transport medium: Air

Scope:

The bidder shall provide all mechanical equipment and motors for dilute phase pneumatic transport systems as described herein:

1. Furnished by Vendor

   A. Pneumatic system blowers and clean air piping
   B. Rotary airlocks
   C. Eductors - as needed for Vendor's system design
   D. Transport lines, both primary and secondary, with abrasion resistant long radius elbows (or Owner approved alternate)
   E. Variable speed metering screw feeders.
   F. Valves, fittings, and flanges as required
   G. Gravity chute work
   H. Automatic isolation valves upstream of SynCoal® injection into each lignite feed line to burners
   I. Electric motors and drives
   J. Instrumentation : zero speed switches, speed sensors, temperature and pressure sensors, pressure switches, etc.
   K. Pneumatic system design drawings and loads for structural support
   L. (Optional Design Case : Vendor supplied PLC for control and monitoring of entire primary and secondary transport system. Allen-Bradley is preferred. Vendor to provide hardware, software, and structured English version of PLC programming.)

2. Owner Furnished

   A. Storage silos with isolation shutoff gates on outlets
   B. Surge bins with isolation shutoff gates on outlets
   C. Conveyor gallery between the process building and the Unit No. 2 building sufficient to act as a pipe rack for the transport lines
   D. System installation, including fabrication and installation of pipe supports by installation contractor
   E. Surge bin supports
   F. Structural steel modifications
   G. Bin vent dust collectors

Bid Proposal:

All proposals shall include as a minimum:

   A. System Cost, including breakout pricing for design options identified above
   B. Freight to the site
   C. Quantities sizes, and manufacturers of blowers
   D. Individual cost of blowers

E. Diameter, length and number of elbows in transport lines
F. An estimate of required assembly time at the site
G. Volumetric flow rate through each transport line
H. Loading and support requirements for all equipment
I. Basic electric motor data including manufacturer, motor horsepower, etc. (see attached motor data sheet for typical data)

Copies of bid proposals are due no later than February 18, 1997 at 12:00 noon MST at Western SynCoal* (Western Energy Company), with copies to Stone and Webster Engineering Corporation and UniField Engineering, Incorporated.

Western Energy Company
P.O. Box 99
Castle Rock Road
Colstrip, MT 59323
Phone : (406) 748-5151, Fax : (406) 748-5115

Attention : Charlie Vincent / Bill Pittman

Stone and Webster Engineering Corporation
7677 East Berry Avenue
Englewood, CO 80111-2137
Fax (303) 741-7670 or 741-7040

Attention : Gordon Webster / Rick Houston / Glenn Todd

UniField Engineering, Inc.
2626 Lillian Avenue
Billings, MT 59101
Fax (406) 245-7112

Attention : Steven Henderson / Clinton Camper

UNIFIELD ENGINEERING, INC.

TEL: (406) 245-4455
FAX: (406) 245-7112

FAX MEMORANDUM

DATE: January 31, 1997

TO: Rick Houston, Stone and Webster Engineering Corporation

XC: Ray Sheldon, Western SynCoal
John Gramza, Minnkota Power Co.
Roger Gazur, Minnkota Power Co.
Dick Schwalbe, Minnkota Power Co.

FROM: Steven D. Henderson, UniField Engineering, Inc.
Clinton Camper, UniField Engineering, Inc.

RE: Pneumatic Conveyance System Meeting Notes That Affect Equipment Specification
Project Memorandum SWEC002, Rev. 02

SWEC, UniField, Western SynCoal and MPC met with Delta Ducon, Air-Cure and Smoot representatives on January 28 & 29, 1997 at the MPC Center, North Dakota site. Topic of discussion was pneumatic conveyance of SynCoal® from the SynCoal® facility storage bins to surge bins located within the boiler house and from surge bins to the Unit No. 1 and No. 2 cyclone burners.

Field tours were given to all pneumatic equipment vendors.

Meeting attendees:

John Gramza, Roger Gazuer and Dick Schwalbe with Minnkota Power Co.
Bill Pittman, Charlie Vincent with Western Energy
Steven Henderson and Clint Camper with UniField Engineering, Inc.
Glenn Todd and Gordon Webster with Stone & Webster Engineering Corporation
Michael Harris, John Johnson and Bill Winger with Air-Cure
Len Potts with Delco Ducon
Mark Rhodes with Smoot

1. Technical specification is due to vendors during first week of February.

2. Bids are due back from vendors by February 10, 1997
   a. Bids to be sent to Stone & Webster Engineering Corporation (SWEC) attention Richard Houston
   b. Bids to be copied to UniField attention Steven D. Henderson
   c. Bid award by February 28, 1997

3. Pneumatic lines from the SynCoal® plant will supported via the SynCoal® facility coal infeed conveyor bridge with pipe supports by others.

4. Surge and feed bin are not part of the pneumatic bid packages but vendors were told that these may be put back into the package later.

5. Air-Cure representative noted that NFPA restrictions may dictate the design pressure for surge bins. Glenn Todd noted that he was aware of NFPA and is working on interpretation of codes to determine the affect on bin design.

6. For each cyclone burner, the lift-line from the down stream flange of the mixing tee, which is located beneath the seal valve of the cyclone separator, is lined with ceramic blocks. Blocks are approximately 1"X2"X6". The mixing tee is unlined. There is an air deflector in the lift-line located near the up stream flange of the mixing tee.

7. It was suggested by MPC that gravity feed systems be considered for feed from surge bins to cyclone burner lift-lines.

8. Typical lift-line pressure is about 20" w.c., but this needs confirmation through field measurement.

9. MPC would like to set SynCoal® feed and have lignite controlled to make up remaining feed requirements.

10. 6:1 turndown was agreed to be adequate with 10:1 being excessive.

11. SynCoal® feed accuracy to be ± 2% at maximum feed rate.

12. Wear resistant elbows are required.

13. MPC uses ceramic lining on their pneumatic feed lines from the silos to the cyclone burners.

14. Design life is 20 years.

15. Care is to be taken not to locate joints in hard to access areas.

16. Design needs to specifically address SynCoal® settling at the bottom of vertical runs in the case of a shut down prior to line clearing.

17. *** Deleted***

18. Would like a signal confirming operation of feed system components.

19. Specification needs to define control input and output.

20. MPC prefers Allen Bradley PCL5 programmable logic controllers.

21. Automatic SynCoal® feed shut off valves are to be provide near the tie in to the lift-lines. These will respond to a main fuel trip or an individual cyclone trip.

22. Fuel shutoff may be for the entire boiler or for a single burner and vendor system needs to accommodate this.

23. If a single blower is used to transport SynCoal® to multiple cyclone burner lift-lines what will be the result of the pressure imbalance in the system when fuel to a single burner is shutdown?

24. Maximum SynCoal® feed rate is 6 tph per lift-line.

25. Vendors to respond to the option of pressurizing Unit No. 1 surge bins to allow the use of a gravity feed system to lift-lines.

26. Currently N2 blanketing is planned for storage bins but not to surge bins.

27. SWEC to provide revised plot plans noting surge bin and burner locations and the empty room in the basement that could be used for air compressor station.

28. MPC suggested that an equipment access doorway could be cut through one of the concrete walls of the empty room in the basement. (Structural review required.)

29. Construction plans need to address installation of pneumatic SynCoal® feed tie-ins on mixing tees/lift-lines during upcoming planned shutdowns.

30. Clint Camper to arrange for samples of SynCoal® to be sent to each pneumatic system vendor (These will be sent from UniField offices on Monday, February 3, 1997).

31. Bin vents for the surge bins are not part of the pneumatic conveyance system vendors scope.

32. Vendors to provide loads and locations recommened for pipe supports to enable structural steel design by SWEC.

33. Design should attempt to have no expansion joints in coal feed lines. Required flexibility should be built into piping system.

34. The mixing tee is unanchored except through connect to other ducts and equipment. It is hung from the separation cyclone which is support by radially mounted lugs. The mixing tee can be moved horizontally a 1/4 inch or more by manually pushing on the side of the air pipe. Vendors will need to build in significant feed line flexibility.

35. Available power is 480 VAC and 4160 VAC.

36. Vendors to supply horsepower loads.

37. Motor starter and motor electrical connections to be supplied by others.

38. Clint Camper will supply SWEC the MPC motor specification. (This information is contained in the Center SynCoal Facility 2.0 Technical Specification section DB-16).

39. Vendors to provide instrumentation recommendations and define in detail provided instrumentation. (This needs to be in accordance with the Center SynCoal Facility 2.0 Technical Specification.)

40. A Vendor capable of supplying a system to accurately feed solids was identified:

    Stamet Inc.
    17244 S Main St., Gardena, CA 90248
    (310) 719 7110, Fax (310) 523-1920

SPECIFICATION
for
PROGRAMMABLE LOGIC CONTROL SYSTEM

1. <u>SCOPE</u>

1.1 This specification describes the requirements for engineering, design, manufacturing, testing, shipping, and start-up of a computer based control system that will be used for control, monitoring, alarm notification, data collection, and operator interface for a vendor supplied system.

The system shall be comprised of the following equipment and services:

a) Microprocessor based Programmable Logic Controllers (PLC's);
b) Analog and discrete signal input/output (I/O) modules;
c) Data communication equipment.
d) Remote operator interface stations;
e) All required software, including the operating system, configuration utilities and a graphics display and control package;

2. REFERENCE SPECIFICATIONS, STANDARDS, CODES, AND DRAWINGS

2.1 The following national codes, standards, and specifications shall form a part of this specification:

Institute for Electrical and Electronics Engineers (IEEE)

IEEE 802.3 Information Technology-Local and Metropolitan Area Networks-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specification

National Electrical Manufacturer's Association (NEMA)

ICS-1 General Standards for Industrial Control and Systems

ICS-6 Enclosures for Industrial Control and Systems

National Fire Protection Association (NFPA)

NFPA 70 National Electric Code

Electronic Industries Association (EIA)

RS-422A Electronic Characteristics of Balanced Voltage Digital Interface Circuits

RS-485 Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

3. TECHNICAL REQUIREMENTS

The Seller shall provide a control system consisting of a PLC, I/O modules, communication equipment, an operator interface and all required software.

The PLC shall consist of a Central Processing Unit (CPU) interfaced to data highways for communication to I/O modules, operator stations, and other peripheral equipment. Performance of the PLC system shall be on a stand alone basis without the support of a higher level host computer.

One Operator Interface Terminal (OIT) will be included in the complete system. A primary operator station (OIT-1, provided by the Buyer) located in the control room will serve as the primary operator interface to the plant. A remote operator station, OIT-2, shall be provided by the Seller to serve as the control station for the provided equipment. All system software for programming and operating operator interface terminal OIT-2 shall be supplied by the Seller.

An Engineering Work Station (EWS) shall be provided by the buyer. The EWS shall be used to configure the complete system. All system software for programming and operating the PLC and OIT shall be supplied by the Seller.

Equipment will be installed in new enclosures, supplied by the Buyer, and in existing enclosures. The equipment will be in a temperature controlled environment between 68 and 72°F with relative humidity between 40 and 60 percent.

3.1 The Seller shall provide a PLC which shall be a digital, solid-state logic device capable of executing the same functions as conventional relays, timers, counters, drum sequencers, and PID loop controllers including the following:

a) Sequential digital logic control;
b) Modulating analog control;
c) Alarm monitoring;
d) Communication;
e) System security;
f) Diagnostics.

The PLC CPU shall as minimum consist of a 16-bit microprocessor which shall be capable of executing relay ladder logic programs and other resident software, and perform on-line mathematical calculations, PID loop control, diagnostics, and alarm functions. The CPU shall be capable of communication with primary rack-mounted I/O modules, remote mounted I/O modules, secondary PLCs on a LAN or data highway, and operator interface devices.

With every scan, the CPU shall automatically sample and update analog and discrete data within registers, coils, function blocks, and local and remote I/O points.

As a minimum, the CPU shall contain and be capable of processing the following:

a) 32 K words of Random Access Memory (RAM) or Erasable Programmable Read Only Memory (EPROM) to contain the ladder logic program, constant and variable data, I/O data, and status data;
b) Maximum CPU scan time of 0.5 milliseconds per 1000 words of memory;
c) 2048 points of I/O capacity, which shall include at least 1024 analog points;
d) 64 PID control loops with a maximum processing time of 1.0 milliseconds per loop. Execution rate shall be adjustable between 0.5 - 25 milliseconds;
e) Analog alarms including low, low-low, high, and high-high process alarm set points;
f) Simultaneous execution of PLCs sharing global programs, memory, and data;
g) Two RS232/422 communication ports for the connection of programming and operator interface devices, CRTs, modems, host computer, or other ASCII devices.

The CPU shall be capable of performing the following higher-level mathematical and data bit/word functions and instructions in order to provide continuous, sequential, and cascade logic control.

a) Floating-point mathematical functions: addition, subtraction, multiplication, division; square, square root, logarithmic, and trigonometric;
b) Floating-point data transfer functions: bit and block move, data compare, bit set, word rotate, block clear;
c) PID loop block functions for control of proportional, integral, and derivative applications. Feedforward, feedback, cascade, and ratio control shall be available along with reset windup protection. Ramp and soak algorithms shall also be provided. Processing time for each loop controller shall be independently selectable;

d) Execution of subroutines containing ladder logic and function blocks. The CPU shall be capable of passing data between subroutines and skipping over blocks of ladder logic or data functions to allow a decrease in scan time;
e) Lead/lag analog time compensation functions;
f) Function blocks for ASCII read and write instructions.

The PLC shall provide a special memory protection feature, either with passwords or keylocks, to prevent unauthorized personnel from manipulating the configuration of the system. Such memory protection shall be installed and accessible in all CPUs and operator stations.

The CPU shall contain a real-time battery-backed clock for system timing and continuous analog and digital data update. It shall be accurate to within one second per day. The frequency of the AC power supply shall not be used as a time standard.

Changes in control configuration or programming shall be possible while the system is on-line without affecting (decommissioning) any other devices in the system besides the nodes in question.

The PLC system shall permit Engineering Work Station software programs to be used in either "on-line" or "off-line" modes without affecting system control and monitoring functions.

In the case of communication failure or poor quality input signal to an I/O module, the controller shall not cease functioning, but shall hold the last good input value.

The PLC shall be capable of operating from nominal 120 V AC 60 Hz ±15% with no filtering required. The PLC power supply shall convert 120 Volt AC supplied power to DC voltage suitable for the Seller's CPUs. Each PLC card or component shall also be provided with self-regulating capability to assure proper operation of the system. The power supply shall contain circuitry to provide for orderly shutdown and storage of the last available I/O data values in the event the incoming power does not meet the specifications. Each PLC rack power supply shall include a "DC power good" status LED or indicator light and a fuse which can be accessed from the front of the rack without removing the power supply. The Seller shall furnish a sufficient number of power supply modules in order to provide 125% of normal power usage to all CPUs, I/O modules, communication modules, and special function modules. The Seller shall size each PLC rack appropriately in order to provide 10% extra space for future expansion. The Seller shall furnish detailed descriptions and drawings of the proper procedure for distribution of AC power to the PLC equipment. Battery back-up shall be provided "on-board" to retain the logic program in non-volatile CPU memory for at least 6 months in the event of loss of external electrical power. The CPU shall have a "low battery" or "battery good" status LED or indicator light.

In the case of a power failure, the outputs shall fail to the de-energized state and the PLC shall also store checksum error bits. When the power is restored and is within tolerances, operation shall automatically resume, provided that the checksum error bits agree with stored bits. If there is any difference between the bit values, indicating a loss of memory or other problem, the PLC shall default to the failure mode, and the CPU "run" light shall not be illuminated.

The PLC shall maintain on-line diagnostic programs, which are transparent to the user, to check the integrity of all PLC components in the system including the CPU, power supply, I/O modules, and operator stations. The operator shall be alerted as soon as a malfunction is detected. On-line diagnostics shall include as minimum:

a) CPU memory failure;
b) CPU memory protection status;
c) CPU battery failure;
d) CPU high temperature failure;
e) Communication errors and port failure;
f) Module, chassis, or power supply failure;
g) Software program failure.

The system diagnostics shall automatically specify the control options available to the operator in the case of alarms, CPU failure, I/O failure, or communication failure.

Status indicator lights or LEDs shall be provided on the CPU to show "standby," "run," and "failure" modes.

The Seller shall specify the proper grounding, shielding, and connecting procedure for all AC and DC grounds. Detailed electrical diagrams showing the proper wiring and grounding connections for each type of equipment in the PLC system, including main CPU racks, I/O modules, and operator stations, shall be furnished.

3.2 Remote I/O modules shall be self contained with power supplies, communications adapters, and I/O circuitry. The Seller shall supply enough I/O modules to accommodate the type and number of points as required with 10% spare I/O and 10% spare space. The I/O modules shall be removable with power applied without either disturbing field wiring or shutting down the processor.

All modules shall be electrically isolated from each other enabling the use of mixed voltages on the same I/O base. All input and output module channels shall be optically isolated and shall be protected from electrical transients to 1500 volts peak.

Screw terminals for the connection of all I/O wiring shall be provided. Each terminal shall hold one No. 12 AWG stranded wire. All I/O modules shall be provided with termination marking strips.

The following types of input and output modules shall be accommodated:

Analog inputs shall be 4-20 mA dc. Analog inputs will be field powered. Analog inputs and outputs shall have at least 12 bit resolution with an accuracy of plus or minus 2% of full scale. All analog inputs used for control/alarms shall have provisions for damping.

All thermocouple inputs shall be Type J. Thermocouple inputs shall have the capability for cold junction compensation of the process signal.

RTD inputs shall be 100 ohm Platinum 3 wire at 0°C or 10 ohm copper wire.

All analog outputs shall be 4-20 mA dc and shall be externally powered.

Digital inputs shall be 24 VDC and 120 VAC dry contact inputs. Digital inputs shall be externally powered. All digital inputs shall have the capability to reverse field contacts from close-to-alarm to open-to-alarm or vice versa. LED's shall be used on the modules to indicate the status of the inputs.

Digital outputs shall be 120 VAC and 24 VDC outputs. 120 VAC contacts shall be rated for 530 VA inrush at 120 VAC and 40 VA continuous at 120 VAC. 24 VDC outputs 24 VDC contacts shall be rated for 1 amp Output contacts shall be conditioned to avoid false operation or damage caused by induced or conducted transients. LEDs shall be used on the modules to indicate the status of the outputs.

The I/O communication system shall be comprised of twisted-shielded pair cable and shall support the installation of at least 16 remote drops on one line running a minimum distance of 2000 feet without modems. The data highway shall operate independently of the various drops on the network, and the number of remote drops shall have no effect on the transmission rate. I/O interface modules shall operate on 24VDC power supplied by the Seller.

3.3 The PLC system shall support two communication platforms. The communication platforms shall allow information to be transferred reliably between the master and slave CPU modules, operator stations, and other peripheral equipment. They shall allow the operator to remotely monitor and control digital and analog loops from the operator interface terminals.

Ethernet TCP/IP communications shall provide communication to the PLC, OIT's and the engineering work station.

Communication to the remote I/O and OIT shall be at the rate of 230k bits/s over a distance of 2,500 feet. Allen-Bradley Remote I/O Link shall be provided for communicate to the remote I/O devices and OIT"s.

3.4 Operator interface Terminals (OIT's) shall provide the means of controlling, monitoring, and manipulating the process, while using the PLC to perform the actual process interface and control functions. They shall access a data base common to the PLC and data acquisition systems.

A remote operator station, shall be provided by the Seller to serve as the control station. OIT shall consist of a panel mounted Allen Bradley PanelView 900 or equal, personal computer with keyboard and display monitor designed to meet NEMA 12 standards for protection from dust, falling dirt, and dripping water, etc. OIT shall be capable of process control, and data display. OIT shall, as a minimum, consist of the following:

a) 240 K application memory;
b) 640X400 pixels, 8.27 in X 5.17 in monochrome display;
c) Programmable function keypad ;
d) Audible alarm notification;
e) *Allen Bradley Remote I/O communication modules;*

f) Allen Bradley PanelView operator system.

The keyboard for OIT shall be contained in a rugged sealed membrane unit designed to meet NEMA 12 standards for protection from dust, falling dirt, and dripping water, etc. There shall be widely spaced keys to enable rapid visual location of keys and accommodation of gloved operators. Raised vinyl between keys shall provide tactile key location. Keys shall be clearly and permanently labeled for function. Labels shall be impervious to normal wear and usage expected for the life of the keyboard. LED indicators shall be imbedded on various keys to indicate keys that are activated for control functions. An acknowledge key shall be provided for alarms. All keys shall be easily redefined and relabeled to suit the user's needs.

OIT shall operate on 120VAC.

3.5 The Seller shall provide all software for programming the PLC and OIT including applications programs, data base programs, and graphics displays. Software shall operate on an IBM compatible engineering work station Provided by the Buyer and be transferable to the PLC and the OIT's. All programming will be performed by the Buyer.

The Seller shall supply diagnostic software for "on-line" or "off-line" troubleshooting of all devices on the PLC network. All software diagnostics shall be interactive in such a way as to alert the operator or Engineer if he has chosen an incorrect action.

All PLC software shall be self documenting, complete with cross-references, and shall include fully annotated ladder and function block diagrams.

Graphics display software shall draw and edit custom graphics, and interface the graphics with dynamic "real-time" data values from the PLC. Graphical symbols may be those provided by the Supplier or any others created by the user. The following graphic and data display configuration functions shall be supported:

a) Creating, editing, copying, and deleting graphics, symbols, tags, and I/O database points;
b) Defining and formatting the data displayed on the graphics, including various engineering units and boolean logic descriptors;
c) Listing and cross-referencing all graphics, symbols, and tags, and I/O database points;

d) Assigning a control function or option display to a graphic, symbol, tag, and I/O point;
e) Library functions for graphics, symbols, tags, and database points;
f) Trending.

Utility software shall be provided by the Seller. Such software shall operate on an IBM compatible computer. The following utilities shall be supported by the software:

a) Creating, deleting, editing, and saving data and configuration files;
b) Verifying the configuration;
c) Diagnostics.

All software licenses shall be furnished with the software.

3.6 The Seller shall quote spare parts as an option for the system. Seller shall supply a list of recommended spare parts for the system including itemized pricing.

All spare parts for equipment covered by this specification shall comply in all respects with the requirements of this specification, specifically including documentation identical in kind and format to that required for the original equipment or material.

INDEX

1.0 SPECIFICATIONS FOR ELECTRIC MOTORS RATED LESS THAN 200 HORSEPOWER

1.1 Scope

These specifications cover general purpose, integral horsepower induction motors designed and built for use in severe industrial service. It is intended that these specifications apply both to motors furnished separately and to those furnished with the driven equipment.

1.2 Standards

Design shall comply with the most recent revision of applicable codes and standards of the following organizations:

AFBMA - Anti-Friction Bearing Manufacturer's Association
- AFBMA-9 Load Ratings and Fatigue Life for Ball Bearings
- AFBMA-11 Load Ratings and Fatigue Life for Roller Bearings

NEMA - National Electric Manufacturer's Association
- MG-1 Standard Publication for Motors and Generators

IEEE - Institute of Electrical and Electronic Engineers
- IEEE 112 Standard Test Procedure for Polyphase Induction Motors and Generators

NFPA - National Fire Protection Association
- NFPA No. 70 National Electrical Code (NEC)

1.3 Electrical Requirements

Voltage and Frequency

Motors less than ½ HP shall be rated at either 120 or 460 volts per Owner specification for operation on a 3-phase, 60 hertz power supply. Motors greater than or equal to ½ HP and less than 200 HP shall be rated 460 volts for operation on a 3-phase, 60 hertz power supply.

Current Density

Current density and heating characteristics shall be such that the motors will not burn-out if subjected to a maximum of 20 seconds stall at locked rotor current.

Service Factor

All motors shall have a 1.15 service factor, and nameplates shall be stamped accordingly.

Efficiency

All motors shall be energy efficient, severe duty unless approved by Owner.

Insulation and Temperature Rise

All motors shall have Class F insulation with corresponding temperature rise according to NEMA Standards. Temperature rise is to be based on 40 degrees C. maximum ambient temperature and 2,000 feet maximum altitude or as stated on the attached data sheet.

1.4 Mechanical Requirements

Enclosures

All motor enclosures shall conform to the electrical classification of the area which they will be installed. At a minimum all motors shall be totally enclosed, fan cooled (TEFC).

Bearings and Lubrication

All motors shall have anti-friction (ball or roller) bearings, sized for average life of at least 100,000 hours under normal V-belt loading conditions. Bearings shall be AFBMA standard sizes.

Motors shall be equipped with end shield mounted ball bearings made to AFBMA standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent relubrication, but facilities shall be provided for adding new grease and draining out old grease without motor disassembly. The bearing housing shall have long, tight, running fits or rotating shields to protect against the entrance of foreign matter into the bearings, or leakage of grease out of the bearing cavity.

Materials

Stator Frames and End Shields

The stator frames and shields for all frame sizes shall be rigid cast iron.

Other External Parts

Fan covers and conduit boxes shall be cast iron for severe duty.

Eye bolts

All motors weighing more than 50 pounds shall be drilled and tapped for a lifting eye bolts. The eye bolts shall be supplied.

Motor Leads

Motor leads into the conduit box shall have the same insulation class as the winding, and be equipped with a numbered brass or copper terminal staked or otherwise mechanically fastened to the lead sufficient to resist 15 pounds pull. Leads shall be marked throughout the entire length to provide identification after terminals are taped or clipped.

Ventilation Fans

Ventilating fans shall be nonsparking, abrasion and chemical resistant, and bidirectional.

Shaft Seals

All motors shall have a synthetic rubber or molded plastic seal located on the shaft at the drive end shield opening to prevent moisture or other foreign material from entering the bearing cavity.

Conduit Boxes

Conduit box mountings shall be arranged for rotation so conduit can be brought in from top, bottom, or either side. Cast iron conduit boxes for all motors shall be tapped for threaded conduit connection. Conduit hole size shall conform to NEC Standards, depending on motor rating.

Nameplates

All motors shall have nameplates of stainless steel.

Connection Diagrams

The motor connection diagram shall be permanently attached to the motor either inside the conduit box or on the motor frame in a location readable from the conduit box side.

External Finish

All motors shall be prime painted with corrosion resisting metal primer, and finish painted with a durable synthetic lacquer or enamel, manufacturer's standard.

Hardware

All bolts, screws, and other external hardware shall be treated for corrosion resistance.

1.5 Tests

Vendor shall conduct routine testing to determine that motors are within quality assurance and control (QAC) limits for electrical or mechanical defects. The routine test shall, as minimum, conform to NEMA Standards. Motor testing procedure shall be in accordance with the American Standard Test Code for polyphase induction motors and generators, Publication IEEE 112. Vendor shall supply copies of QAC documentation including variability and control limits for motors supplied.

1.6 Preparation for Shipment

Protective Coating

Before shipment, the shaft extension and any other bare exposed metal parts of each motor shall be coated with an easily removable rust preventative.

Packaging

All motors shall be securely fastened to a hardwood skid or pallet for fork truck handling, and be covered for protection against dirt and moisture during transit and for short time outdoor storage.

1.7 Acceptable Suppliers

Acceptable Suppliers and models are:

Toshiba	EQP III-XS
General Electric	Extra Severe Duty (ESD)
Reliance Electric	Duty Master XT/XE

Siemens Allis	Type RCZE-SD
U.S. Electrical Motors	Corro-Duty Type TCE

1.8 Application

Use of Service Factor

Original equipment manufacturers or other suppliers providing motors by this specification are not to use the 1.15 service factor rating. They should consider the motors having 1.0 service factor, and select the next larger size when maximum brake horsepower requirements exceed a particular standard horsepower rating.

Specific Requirements

The motor Vendor, whether original equipment manufacturer or other supplier, is responsible to ensure the suitability of each motor to the driven equipment. This is to include the conditions and applicable requirements that may be attached .

2.0 SPECIFICATIONS FOR ELECTRIC MOTORS RATED 200 HORSEPOWER OR MORE

2.1 Scope

These specifications cover general purpose, integral horsepower induction motors designed and built for use in severe industrial service. It is intended that these specifications apply both to motors furnished separately and to those furnished with the driven equipment.

2.2 Standards

Design shall comply with the most recent revision of applicable codes and standards of the following organizations:

AFBMA - Anti-Friction Bearing Manufacturer's Association

AFBMA-9	Load Ratings and Fatigue Life for Ball Bearings
AFBMA-11	Load Ratings and Fatigue Life for Roller Bearings

NEMA - National Electric Manufacturer's Association

MG-1	Standard Publication for Motors and Generators

IEEE - *Institute of Electrical and Electronic Engineers*

IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators

NFPA - National Fire Protection Association

NFPA No. 70	National Electrical Code (NEC)

2.3 Electrical Requirements

Voltage and Frequency

Motors 200 HP and larger shall be rated 4,000 volts for operation on a 3-phase, 60 hertz power supply.

Motors shall be designed for across-the-line starting and shall be capable of accelerating the connected load to full load speed with a constant 80% of rated voltage at the motor terminals.

The full load current when operating at +/-10% of rated voltage shall not exceed 1.11 times rated full load current.

Motor safe locked rotor time at rated locked rotor current shall be at least 10% greater than the maximum accelerating time at minimum specified starting voltage.

Current Density

Current density and heating characteristics shall be such that the motors will not burn-out if subjected to a maximum of 20 seconds stall at locked rotor current.

Efficiency

All motors shall be energy efficient, severe duty unless approved by Owner.

Service Factor

All motors shall have a 1.15 service factor, and nameplates shall be stamped accordingly.

Where repetitive starting instructions are necessary, these instructions shall be clearly indicated on the motor nameplate.

Motors shall be capable of operation up to and including their service factor rating with the voltage variation, the frequency variation, and the combination of voltage and frequency variation as defined in NEMA MG1-12.43, MG1-12.44 and MG1-12.45 for integral horsepower motors and NEMA MG1-20-45a for large apparatus motors.

Insulation and Temperature Rise

All motors shall have Class F insulation with corresponding temperature rise according to NEMA Standards. Temperature rise is to be based on maximum ambient temperature and altitude as stated in DB-01.

Motors windings shall be equipped with stator RTDs. These RTDs shall be 100 ohm platinum.

2.4 Mechanical Requirements

Enclosures

All motor enclosures shall conform to the electrical classification of the area which they
will be installed. At a minimum all motors shall be totally enclosed, fan cooled.

Bearings and Lubrication

All motors shall have anti-friction (ball or roller) bearings, sized for average life of at least 100,000 hours under normal V-belt loading conditions. Bearings shall be AFBMA standard sizes.

Motors shall be equipped with end shield mounted ball bearings made to AFBMA standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent relubrication, but facilities shall be provided for adding new grease and draining out old grease without motor disassembly. The bearing housing shall have long, tight, running fits or rotating shields to protect against the entrance of foreign matter into the bearings, or leakage of grease out of the bearing cavity.

Motors shall be equipped with bearing RTD's. These RTDs shall be 100 ohm platinum.

Materials

1. Stator Frames and End Shields

The stator frames and shields for all frame sizes shall be rigid cast iron.

Eye bolts

All motors shall be drilled and tapped for a lifting eye bolts. The eye bolts shall be supplied.

Motor Leads

Motor leads into the conduit box shall have the same insulation class as the winding, and be equipped with a numbered brass or copper terminal staked or otherwise mechanically fastened to the lead sufficient to resist 15 pounds pull. Leads shall be marked throughout the entire length to provide identification after terminals are taped or clipped.

Ventilation Fans

Ventilating fans shall be nonsparking, abrasion and chemical resistant, and bidirectional.

Shaft Seals

All motors shall have a synthetic rubber or molded plastic seal located on the shaft at the drive end shield opening to prevent moisture or other foreign material from entering the bearing cavity.

Conduit Boxes

Conduit box mountings shall be arranged for rotation so conduit can be brought in from top, bottom, or either side. Cast iron conduit boxes for all motors shall be tapped for threaded conduit connection. Conduit hole size shall conform to NEC Standards, depending on motor rating.

Nameplates

All motors shall have nameplates of stainless steel.

Connection Diagrams

The motor connection diagram shall be permanently attached to the motor either inside the conduit box or on the motor frame in a location readable from the conduit box side.

External Finish

All motors shall be prime painted with corrosion resisting metal primer, and finish painted with a durable synthetic lacquer or enamel, manufacturer's standard.

Hardware

All bolts, screws, and other external hardware shall be treated for corrosion resistance.

2.5 Tests

Vendor shall conduct routine testing to determine that motors are within quality assurance and control (QAC) limits for electrical or mechanical defects. The routine test shall, as minimum, conform to NEMA Standards. Motor testing procedure shall be in accordance with the American Standard Test Code for polyphase induction motors and generators, Publication IEEE 112. Vendor shall supply copies of QAC documentation including variability and control limits for motors supplied.

2.6 Preparation for Shipment

Protective Coating

Before shipment, the shaft extension and any other bare exposed metal parts of each motor shall be coated with an easily removable rust preventative.

Packaging

All motors shall be securely fastened to a hardwood skid or pallet for fork truck handling, and be covered for protection against dirt and moisture during transit and for short time outdoor storage.

2.7 Acceptable Suppliers

Acceptable Suppliers and models are:

Toshiba	(1,250 Hp or less)
General Electric	
Reliance Electric	(1,250 Hp or less)
Siemens Allis	
U.S. Electrical Motors	(1,250 Hp or less)

2.8 Application

Use of Service Factor

Original equipment manufacturers or other suppliers providing motors by this specification are not to use the 1.15 service factor rating. They should consider the motors having 1.0 service factor, and select the next larger size when maximum brake horsepower requirements exceed a particular standard horsepower rating.

Specific Requirements

The motor Vendor, whether original equipment manufacturer or other supplier, is responsible to ensure the suitability of each motor to the driven equipment. This is to include the conditions and applicable requirements that may be attached.

STONE & WEBSTER ENGINEERING CORPORATION

INDUCTION MOTOR DATA

PAGE NO.

J.O. NO.

CLIENT : Western SynCoal

PROJECT: Center SynCoal

FURNISHED BY DATE BY

MARK OR ITEM NO.

PURCHASER'S REQUIREMENTS	** DATA FURNISHED BY BIDDER
SERVICE	MAKE **
TYPE	FRAME NO. **
NO. OF UNITS	HORSEPOWER **
MOUNTING	SERVICE FACTOR **
ELEC. CHARACTERISTICS V PH HZ	FULL LOAD RPM
SYNCH. SPEED, RPM	FULL LOAD AMP
HORSEPOWER	LOCKED ROTOR AMP
SERVICE FACTOR	STARTING TORQUE, % FL
ENCLOSURE (SEE NOTE 1)	PULL-OUT TORQUE, % FL
INSULATION CLASS	EFF-FULL LOAD, %
INSULATION TREATMENT	EFF-3/4 LOAD, %
AMBIENT TEMP - C	EFF-1/2 LOAD, %
STATOR TEMP RISE - C	P.F.-FULL LOAD, %
BEARING TYPE	P.F.-3/4 LOAD, %
BEARING TEMP RELAY	P.F.-1/2 LOAD, %
BEARING THERMOCOUPLE	P.F. AT STARTING, %
HALF COUPL OR SHEAVE MTD BY	SHORT CIRCUIT A-C TIME CONSTANT SEC.
ROTATION*	X/R RATIO
WK^2 OF DRIVEN EQUIP. ($LB\text{-}FT^2$)	SPACE HTRS. TOTAL WATTS
BRKWY. TORQ. DRVN. EQUIP.	RADIAL-BEARING TYPE
OVERSIZE CONDUIT BOX	THRUST-BEARING TYPE
COND. BOX LOCATION*	BEARING SERVICE - HR
SPACE HEATERS, VOLTAGE, PHASE	NORMAL BRG. OPER. TEMP. - C
SPLIT END BELLS	NET WEIGHT - LB **
TERMINAL LUGS, TYPE	OIL COOL SYS. REQ'D
STATOR HIGH TEMP DEVICE	BRG. OIL PRESS. RANGE, PSI
ADJUSTABLE SLIDE RAILS	BRG. OIL REQ'D EA. BRG, GPM
SOLEPLATES	NAMEPLATE CODE LETTER
PROJECT ELEV., FT.	PERMISSIBLE STARTS PER HR WITH:
SHAFT (HOLLOW, SOLID)	MOTOR AT AMBIENT TEMP.
COUPLING (SELF-RELEASE,	MOTOR AT RATED TOTAL TEMP.
SOLID, NONREVERSING,	TYPE SEALED INSUL SYS.
ADJUSTABLE, FLEXIBLE)	DESCRIPTION OF INSUL SYS.
DOWNTHRUST - CONTINUOUS	MAX. STALL TIME WITH L.R. AMPS, SEC.
UPTHRUST- CONTINUOUS	ACCEL TIME, FULLY LOADED
UPTHRUST - MOMENTARY	WITH 100% V. SEC.
DOWNTHRUST - MOMENTARY	WITH 80% V. SEC.
	WITH % V. SEC.
SIDE THRUST	
MAX REVERSE SPEED	
DRAIN PLUG AND VENT	
AIR INTAKE AND DISCHARGE SCREENS	WK^2 OF ROTOR, $LB\text{-}FT^2$
C.T. RATIO	
SURGE CAPACITORS	
ANTI-FRICT. BRG. SERVICE-HR	
MINIMUM STARTING VOLTAGE%	
REMARKS:	REMARKS:
ALL PERFORMANCE DATA BASED ON NORMAL	ALL PERFORMANCE DATA BASED ON NORMAL
RATED VOLTAGE AND FREQUENCY	RATED VOLTAGE AND FREQUENCY
ITEMS 34-44 APPLY TO VERTICAL MOTORS ONLY	
NOTE 1 : SUITABLE FOR CLASS II, DIV.2, GROUP F	
*VIEWED FROM END OPPOSITE COUPLING END	

SYSTEM REQUIREMENTS

Flow rate - 0 to 6 tons per hour per system

Minimum accuracy - +/- 2% on a volumetric basis

Number of delivery points

Unit 1 - seven (7)
Unit 2 - twelve (12)

SYNCOAL PROPERTIES

Sizing

Size	Individual %	Cumulative %
+ 3.5 mesh	0.00	0.00
3.5 mesh by 8 mesh	39.81	39.81
8 mesh by 50 mesh	52.59	92.40
50 mesh by 100 mesh	3.96	96.36
minus 200 mesh	3.64	100.00

Bulk Density

38 - 42 pounds per cubic foot

Description

A dried coal product

PRELIMINARY

11-21-96
REV. 0

EQUIPMENT LIST FOR SYNCOAL PROJECT			
MINNKOTA POWER PLANT, UNIT #1 AND UNIT #2			
CENTER, NORTH DAKOTA			
UNIT #1	**SIZE,**	**CAPACITY**	**QUANTITY**
PNEUMATIC BLOWER SKID	36	TPH	1
SYNCOAL STORAGE BIN OUTFEED AIR LOCK	36	TPH	1
MANUAL SHUTOFF GATE@OUTFEED OF SURGE	6	TPH	7
SCREW FEEDER INLET ROTARY AIR LOCK	6	TPH	7
VARIABLE SPEED SCREW FEEDER	6	TPH	7
PNEUMATIC BLOWER SKID TO CONVEY FROM			
SURGE BIN TO BURNER CYCLONES	18	TPH	1
UNIT #2	**SIZE,**	**CAPACITY**	**QUANTITY**
PNEUMATIC BLOWER SKID	36	TPH	2
SYNCOAL STORAGE BIN OUTFEED AIR LOCK	36	TPH	2
MANUAL SHUTOFF GATE@OUTFEED OF SURGE	6	TPH	12
SCREW FEEDER INLET ROTARY AIR LOCK	6	TPH	12
VARIABLE SPEED SCREW FEEDER	6	TPH	12
PNEUMATIC BLOWER SKID TO CONVEY FROM			
SURGE BIN TO BURNER CYCLONES	18	TPH	2

Jenike & Johanson, inc.

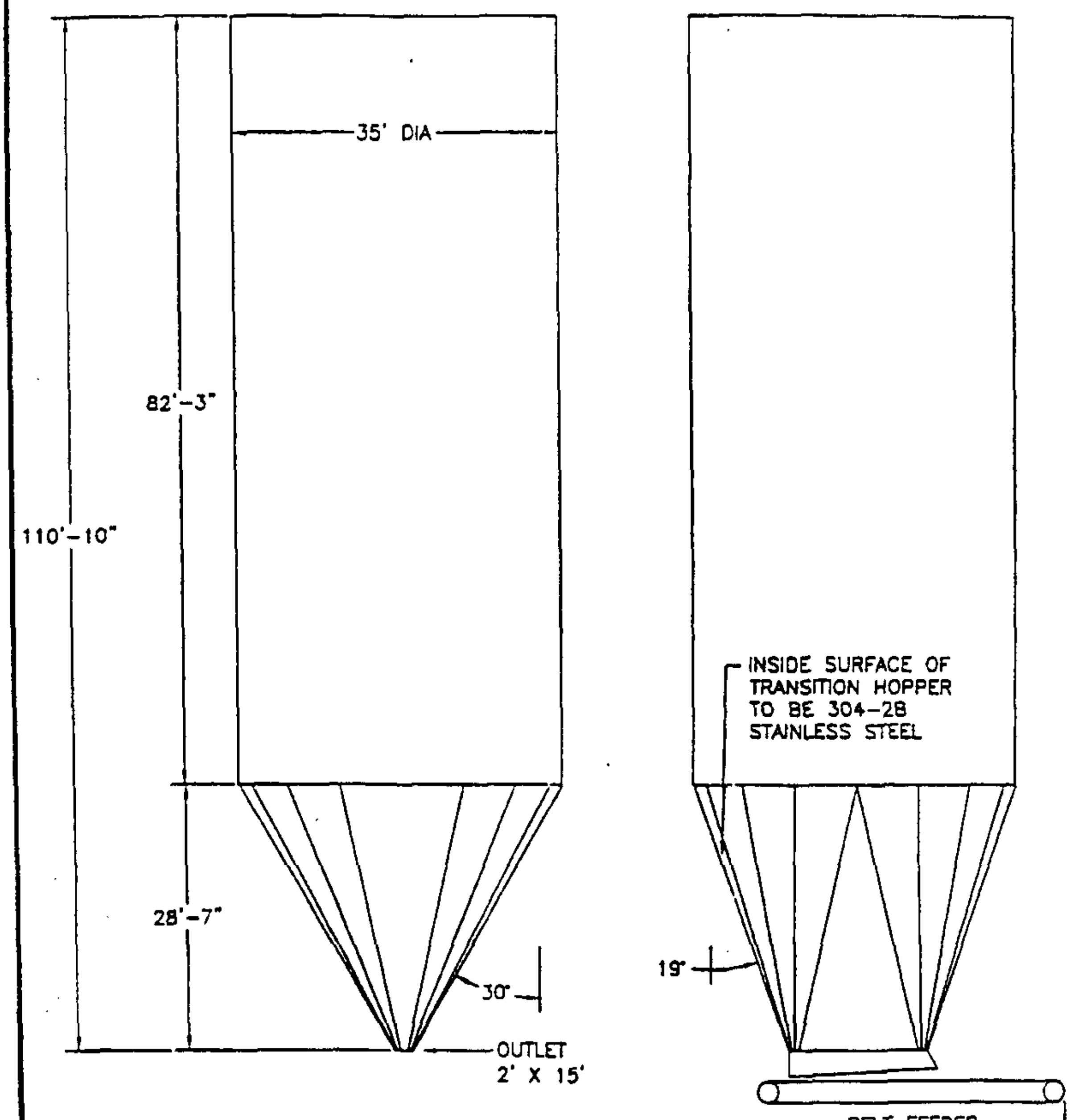
Facsimile Transmission

November 27, 1996 5 Page(s)

TO:	**Richard Houston**	FROM:	**Tom Troxel**
COMPANY:	**Stone & Webster**	COMPANY:	**Jenike & Johanson, Inc.**
FAX #:	**(303) 741-7670**	FAX #:	**(805) 541-4680**
SUBJECT:	**Center Syncoal Project**	VOICE #:	**(805) 541-0901**

Dear Rich:

The attached sketches show preliminary recommendations for the lignite and syncoal storage silos and feeders.



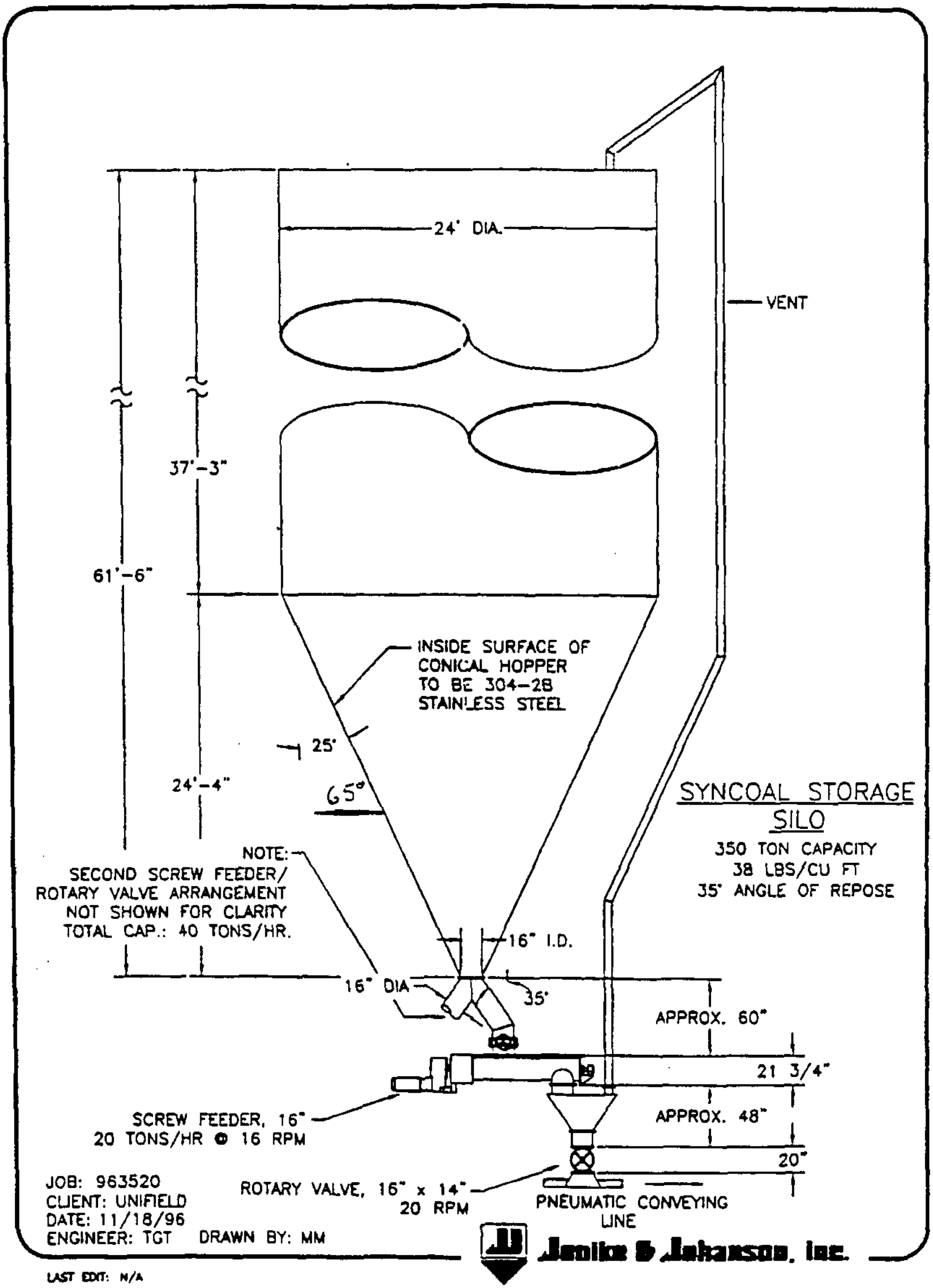
LIGNITE SILO

1800 TON CAPACITY
44 LBS/CU FT
35° ANGLE OF REPOSE

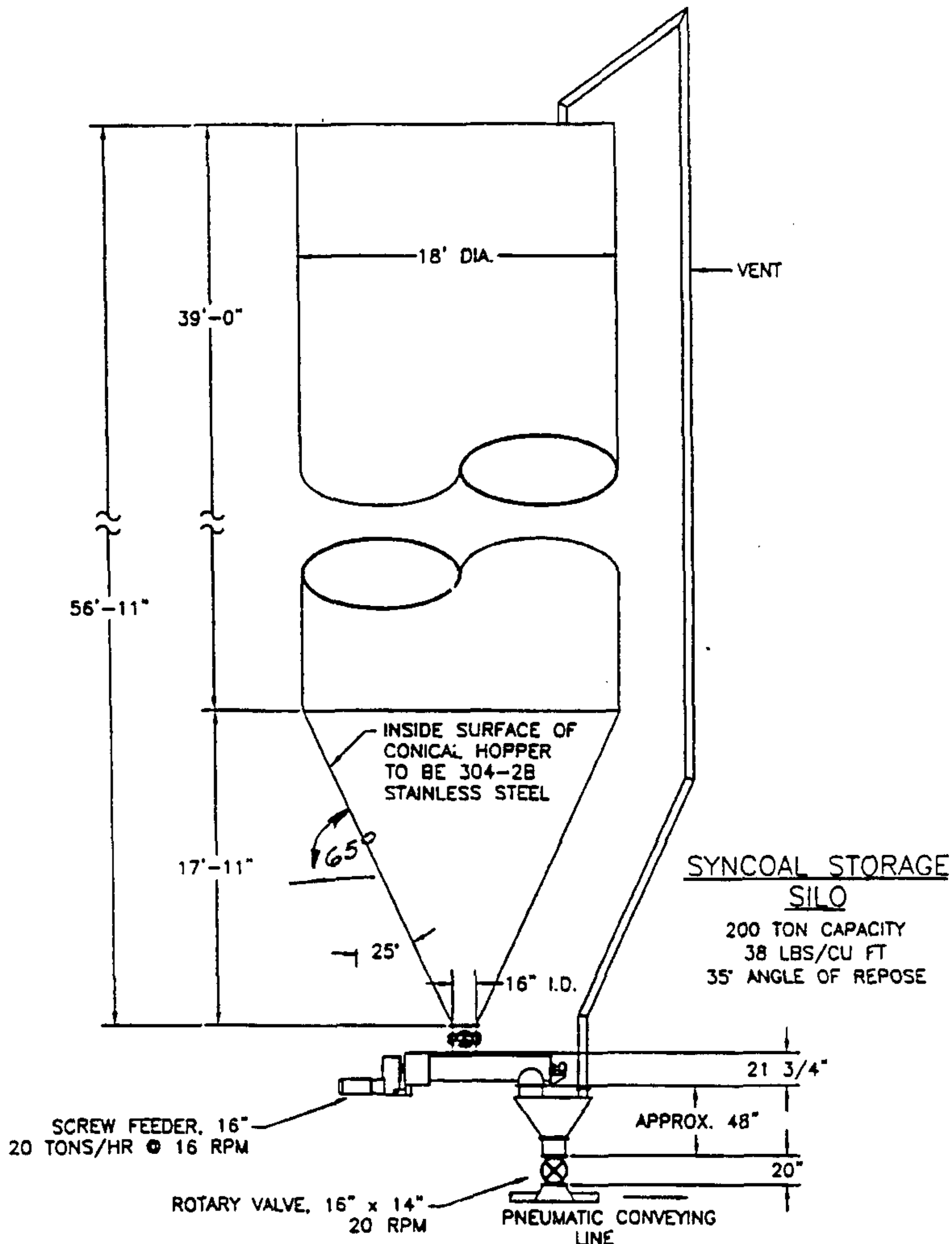
JOB: 963520
CLIENT: UNIFIELD
DATE: 11/18/96
ENGINEER: TGT DRAWN BY: MM

Jenike & Johanson, Inc.

LAST EDIT: N/A


24' DIA.
VENT
37'-3"
61'-6"
INSIDE SURFACE OF
CONICAL HOPPER
TO BE 304-2B
STAINLESS STEEL
25'
24'-4"
65°
SYNCOAL STORAGE
SILO
350 TON CAPACITY
38 LBS/CU FT
35' ANGLE OF REPOSE
NOTE:
SECOND SCREW FEEDER/
ROTARY VALVE ARRANGEMENT
NOT SHOWN FOR CLARITY
TOTAL CAP.: 40 TONS/HR.
16" I.D.
16" DIA
35'
APPROX. 60"
21 3/4"
SCREW FEEDER, 16"
20 TONS/HR @ 16 RPM
APPROX. 48"
20"
ROTARY VALVE, 16" x 14"
20 RPM
PNEUMATIC CONVEYING
LINE
JOB: 963520
CLIENT: UNIFIELD
DATE: 11/18/96
ENGINEER: TGT
DRAWN BY: MM
Jenike & Johanson, Inc.

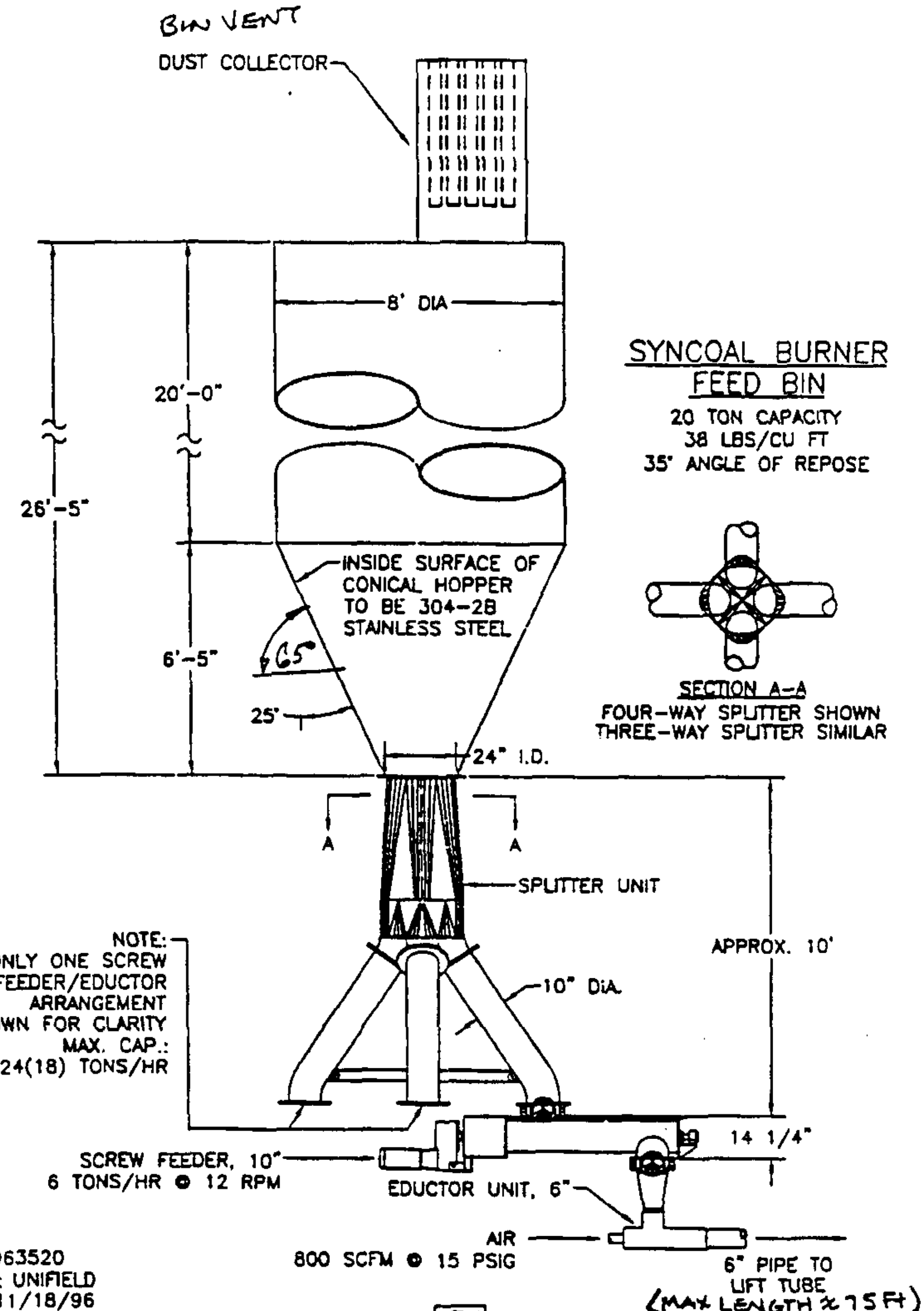
LAST EDIT: N/A



JOB: 963520
CLIENT: UNIFIELD
DATE: 11/18/96
ENGINEER: TGT DRAWN BY: MM

Jenike & Johanson, Inc.

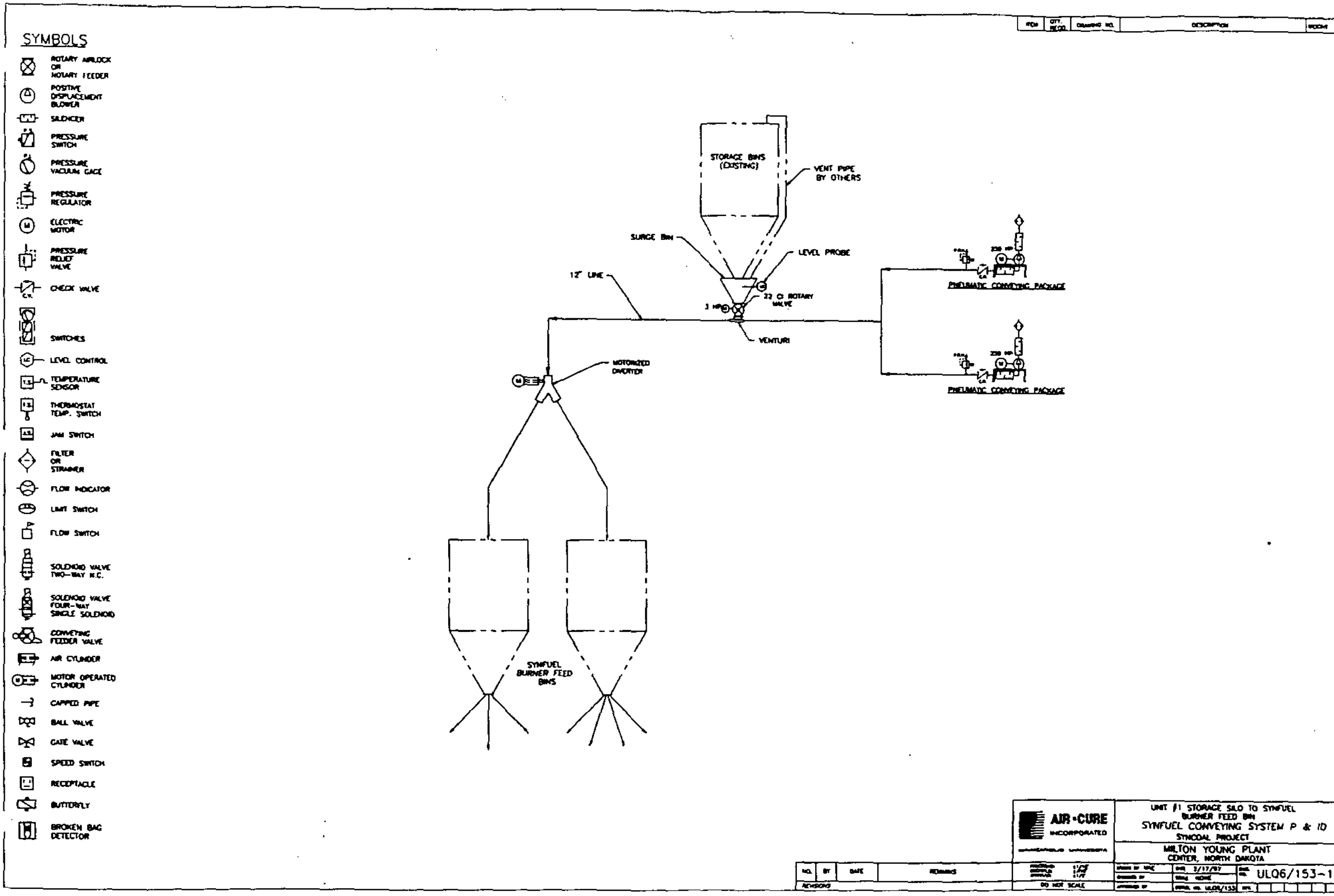
LAST EDIT: N/A

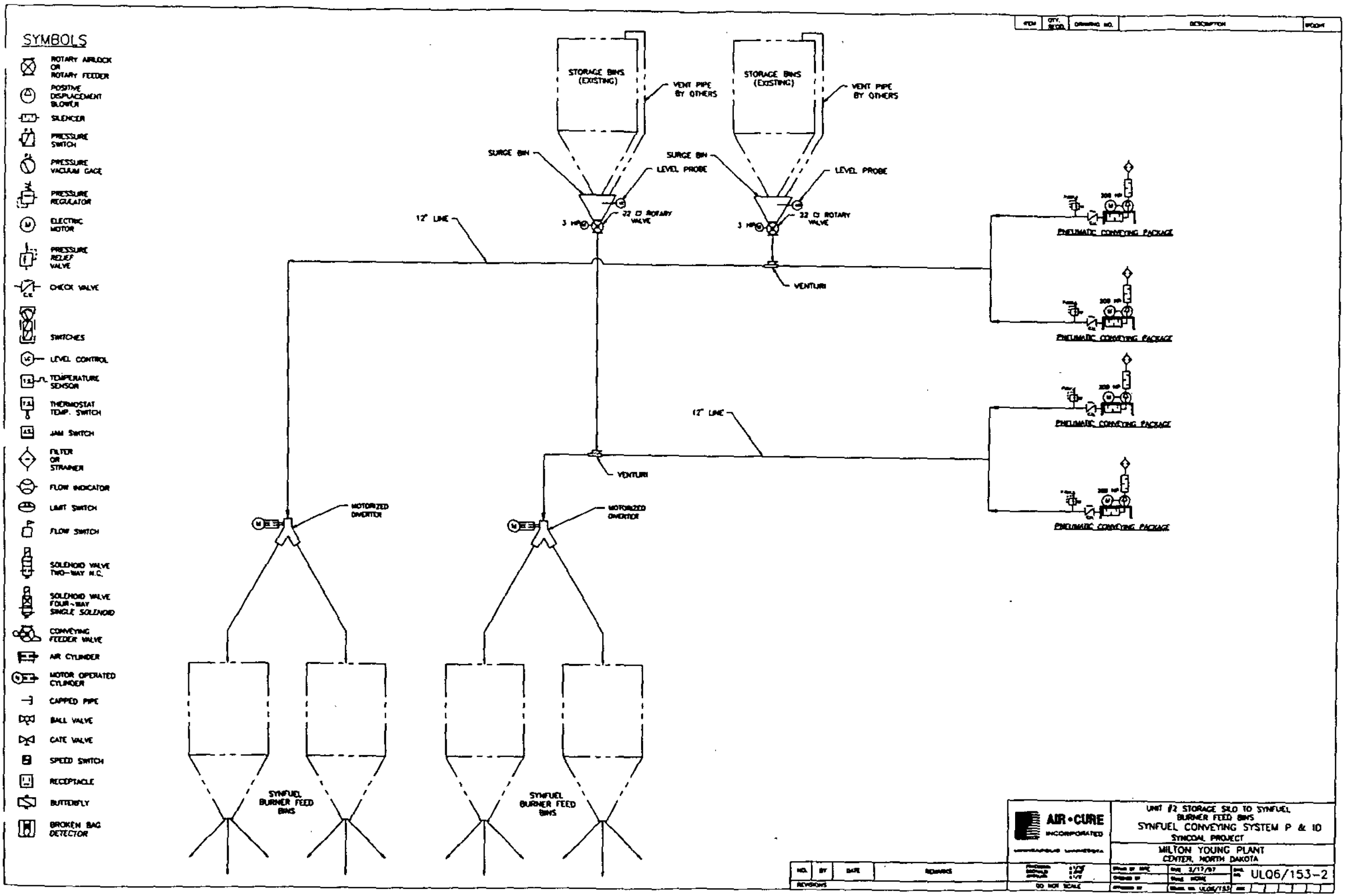


JOB: 963520
CLIENT: UNIFIELD
DATE: 11/18/96
ENGINEER: TGT DRAWN BY: MM

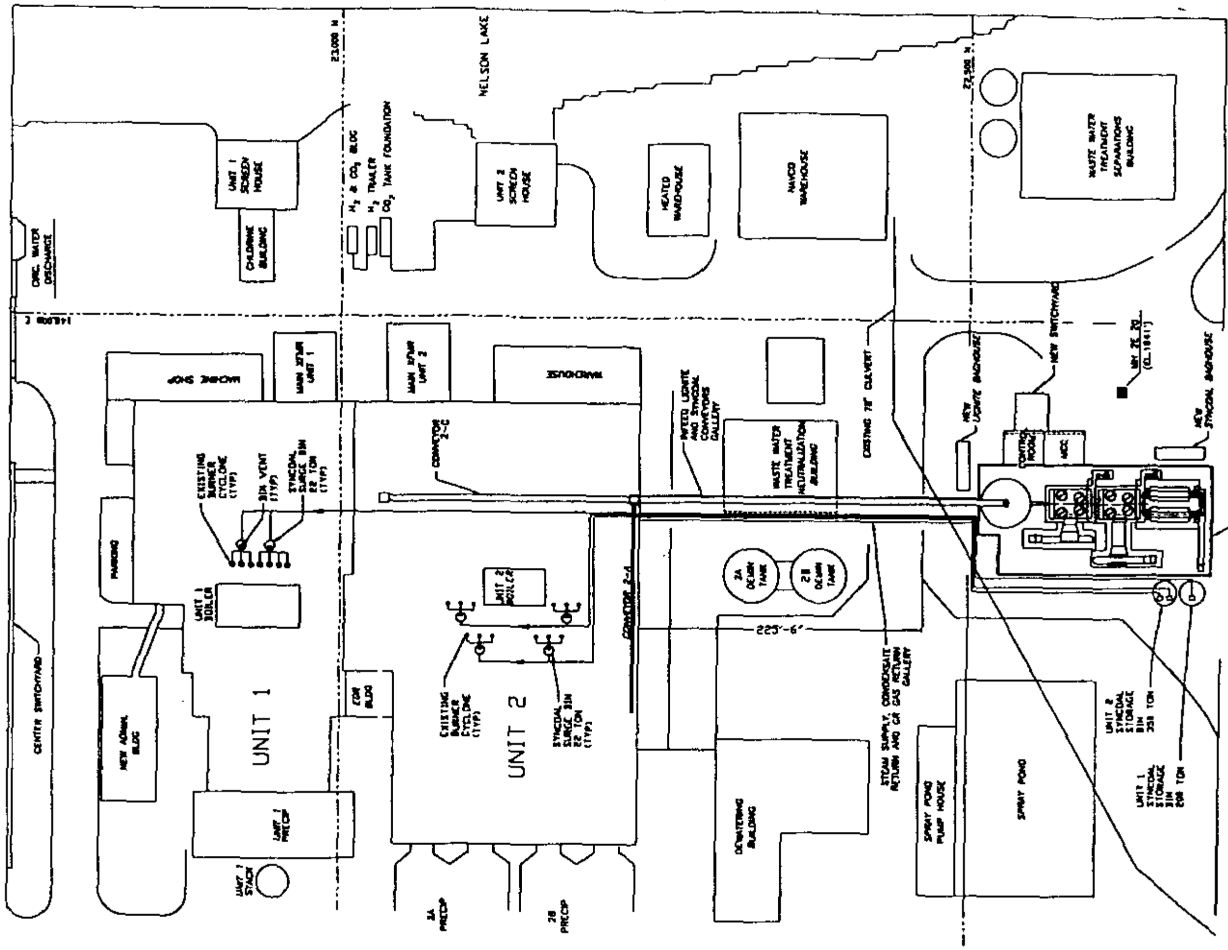
Jenike & Johanson, Inc.

LAST EDIT: N/A


SYMBOLS
ROTARY AIRLOCK OR ROTARY FEEDER
POSITIVE DISPLACEMENT BLOWER
SILENCER
PRESSURE SWITCH
PRESSURE VACUUM GAGE
PRESSURE REGULATOR
ELECTRIC MOTOR
PRESSURE RELIEF VALVE
CHECK VALVE
SWITCHES
LEVEL CONTROL
TEMPERATURE SENSOR
THERMOSTAT TEMP. SWITCH
JAM SWITCH
FILTER OR STRAINER
FLOW INDICATOR
LIMIT SWITCH
FLOW SWITCH
SOLENOID VALVE TWO-WAY N.C.
SOLENOID VALVE FOUR-WAY SINGLE SOLENOID
CONVEYING FEEDER VALVE
AIR CYLINDER
MOTOR OPERATED CYLINDER
CAPPED PIPE
BALL VALVE
GATE VALVE
SPEED SWITCH
RECEPTACLE
BUTTERFLY
BROKEN BAG DETECTOR
STORAGE BINS (EXISTING)
VENT PIPE BY OTHERS
SURGE BIN
LEVEL PROBE
12" LINE
22 CI ROTARY VALVE
VENTURI
MOTORIZED DIVERTER
PNEUMATIC CONVEYING PACKAGE
PNEUMATIC CONVEYING PACKAGE
SYNFUEL BURNER FEED BINS
AIR-CURE INCORPORATED
UNIT #1 STORAGE SILO TO SYNFUEL BURNER FEED BIN
SYNFUEL CONVEYING SYSTEM P & ID
SYNCOAL PROJECT
MILTON YOUNG PLANT
CENTER, NORTH DAKOTA
DO NOT SCALE
ULQ6/153-1



SYMBOLS
ROTARY AIRLOCK OR ROTARY FEEDER
POSITIVE DISPLACEMENT BLOWER
SILENCER
PRESSURE SWITCH
PRESSURE VACUUM GAGE
PRESSURE REGULATOR
ELECTRIC MOTOR
PRESSURE RELIEF VALVE
CHECK VALVE
SWITCHES
LEVEL CONTROL
TEMPERATURE SENSOR
THERMOSTAT TEMP. SWITCH
JAM SWITCH
FILTER OR STRAINER
FLOW INDICATOR
LIMIT SWITCH
FLOW SWITCH
SOLENOID VALVE TWO-WAY N.C.
SOLENOID VALVE FOUR-WAY SINGLE SOLENOID
CONVEYING FEEDER VALVE
AIR CYLINDER
MOTOR OPERATED CYLINDER
CAPPED PIPE
BALL VALVE
GATE VALVE
SPEED SWITCH
RECEPTACLE
BUTTERFLY
BROKEN BAG DETECTOR
STORAGE BINS (EXISTING)
VENT PIPE BY OTHERS
SURGE BIN
LEVEL PROBE
22 CI ROTARY VALVE
3 HP
12" LINE
VENTURI
MOTORIZED DIVERTER
SYNFUEL BURNER FEED BINS
200 HP
PNEUMATIC CONVEYING PACKAGE
ITEM
QTY. REQD.
DRAWING NO.
DESCRIPTION
WEIGHT
AIR•CURE INCORPORATED
UNIT #2 STORAGE SILO TO SYNFUEL BURNER FEED BINS
SYNFUEL CONVEYING SYSTEM P & ID
SYNCOAL PROJECT
MILTON YOUNG PLANT
CENTER, NORTH DAKOTA
ULO6/153-2
NO.
BY
DATE
REMARKS
REVISIONS
DO NOT SCALE



THIS DRAWING CREATED ELECTRONICALLY

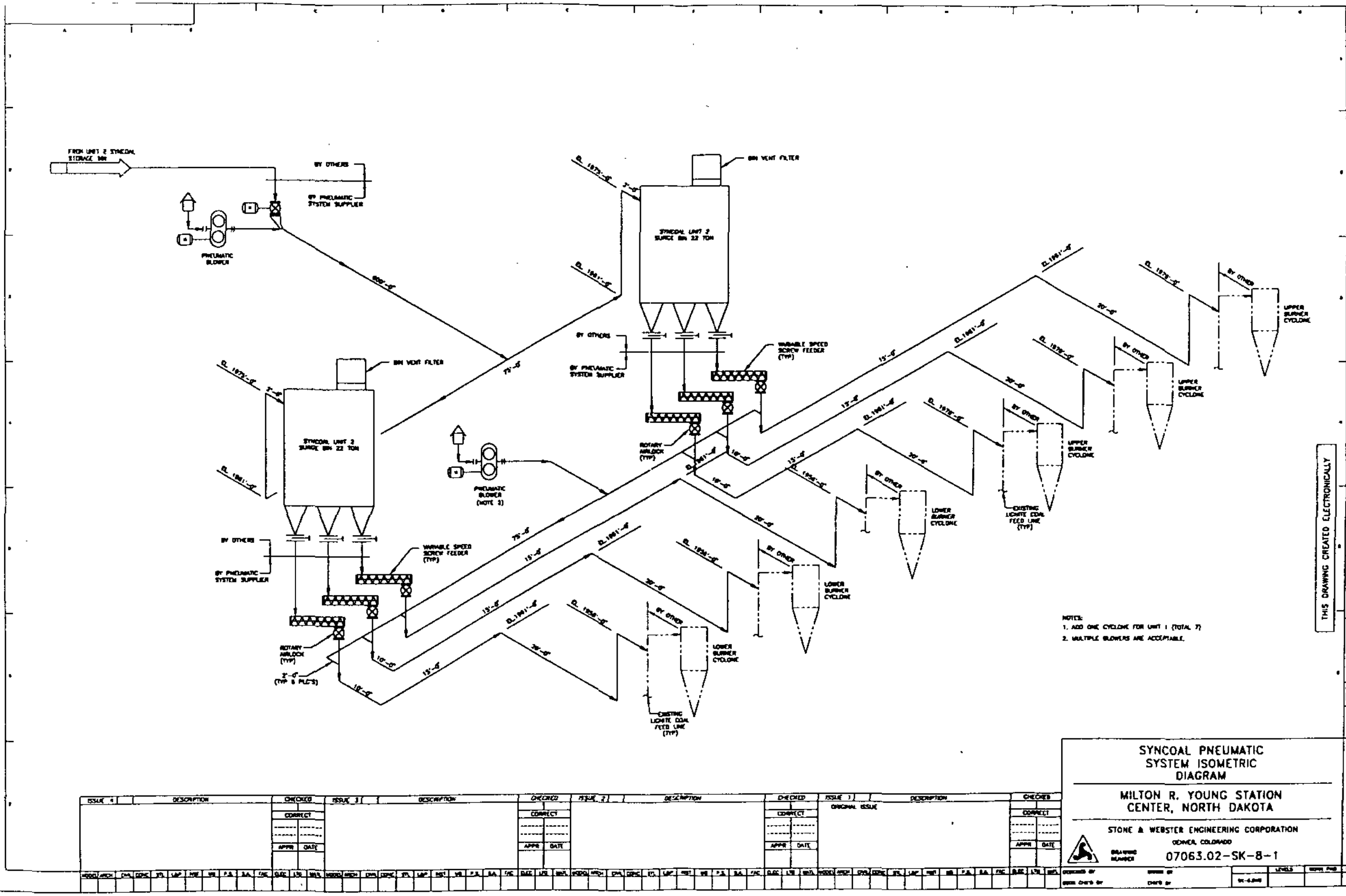
SYNCOAL PRODUCTION PLANT PLOT PLAN

MILTON R. YOUNG STATION
CENTER, NORTH DAKOTA

STONE & WEBSTER ENGINEERING CORPORATION
DENVER, COLORADO

DRAWING NUMBER 07063.01-SK-3B

ISSUE 4	DESCRIPTION	CHECKED	ISSUE 3	DESCRIPTION	CHECKED	ISSUE 2	DESCRIPTION	CHECKED	ISSUE 1	DESCRIPTION	CHECKED
		CORRECT			CORRECT			CORRECT		ORIGINAL ISSUE	CORRECT
		APPR DATE			APPR DATE			APPR DATE			APPR DATE


FROM UNIT 2 SYNCOAL STORAGE BIN
BY OTHERS
BY PNEUMATIC SYSTEM SUPPLIER
PNEUMATIC BLOWER
PNEUMATIC BLOWER (NOTE 2)
BIN VENT FILTER
SYNCOAL UNIT 2 SURGE BIN 22 TON
VARIABLE SPEED SCREW FEEDER (TYP)
ROTARY AIRLOCK (TYP)
UPPER BURNER CYCLONE
LOWER BURNER CYCLONE
BY OTHER
EXISTING LIGNITE COAL FEED LINE (TYP)
NOTES:
1. ADD ONE CYCLONE FOR UNIT 1 (TOTAL 7)
2. MULTIPLE BLOWERS ARE ACCEPTABLE.
THIS DRAWING CREATED ELECTRONICALLY
SYNCOAL PNEUMATIC SYSTEM ISOMETRIC DIAGRAM
MILTON R. YOUNG STATION CENTER, NORTH DAKOTA
STONE & WEBSTER ENGINEERING CORPORATION
DENVER, COLORADO
DRAWING NUMBER 07063.02-SK-8-1
ISSUE 1 ORIGINAL ISSUE
DESCRIPTION
CHECKED
CORRECT
APPR DATE

APPENDIX C-1

DRYER SELECTION DATA

WESTERN SYNCOAL® COMPANY
CENTER SYNCOAL® PRELIMINARY ENGINEERING

Bid Analysis and Recommendations

Dryers
January 21, 1996, Rev. 0

Reference Documents:	Dryers Bid Tabulation - January 11, 1996, Rev. 0 Dryers Matrix Evaluation - January 11, 1996, Rev. 1

1.0 Summary and Recommendations

Three (3) vendors were contacted to supply bids for the Dryers to be installed at the proposed Center SynCoal® facility. Three (3) proposals were received, all of which were technically acceptable and sufficiently in compliance with the Specification criteria to warrant further conditioning. The proposal from Hosokawa Bepex arrived considerably late, allowing insufficient time to fully condition the tender.

The proposal from Svedala Holo-Flite (Holo-Flite) provided advantages based on robustness of construction, cost economy, and significant manufacturer's operating experience in similar applications.

2.0 Bid Summary

The Dryers inquiry document was issued to three (3) vendors for bidding. All three (3) vendors contacted responded with acceptable quotations. The responses were organized into a bid tabulation form dated January 11, 1996, for further bid review and conditioning. Table 1 presents a cost summary of the bids received, less freight costs.

3.0 Technical Bid Analysis

Bids received were evaluated on a technical basis to determine strengths and weaknesses in key aspects of the proposal. The bid tabulation form included in this bid package provides a summary of the significant aspects of the proposals. This summary includes system construction, pricing, shipping and other information from the proposals.

Additionally, a quantitative matrix evaluation was prepared for comparison of the various tenders, particularly with the intention of providing bid equalization in consideration of the significant differences in the equipment proposed. Evaluation categories were established based on particular areas of concern including general arrangement compatibility, similar operation experience, simplicity and robustness of construction and commercial terms. Evaluation weighting was established on a zero to ten scale, with zero being unacceptable and ten being superlative. Actual weighting values were selected through design group discussion of all aspects of each tender, with an attempt made to establish an objective evaluation.

The following section summarizes the most notable features and conclusions of the Dryer bids.

Table 1
Dryers
Bid Summary

Manufacturer	Equipment Configuration	Dryers	
Heyl & Patterson	Two (2) Units: MultiDisc Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$78,500 $160,000 $1,331,500 **$1,570,000**
Holo-Flite	Six (6) Units: Multiple Screw Conveyor Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$5,000 incl. $15,000 incl. $1,993,320 **$1,993,320**
Hosokawa Bepex	One (1) Unit: TorusDisc Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$unknown $unknown $unknown **$2,000,000+**

3.1 Dryers

The inquiry documents issued for bid included a performance specification based on data from the current Mass and Energy Balance. No particular equipment configuration was specified; it was the intention of the performance bidding to allow each manufacturer to apply their expertise in design of heat transfer equipment for the application.

The recommendation for selection of the Holo-Flite equipment is based on robustness of construction, cost economy, and significant manufacturer's operating experience in similar applications. Holo-Flight offered six (6) screw conveyor type heat exchange units, each with four (4) internal screw conveyor assemblies. Material moves through the unit in the manner of a multiple screw feeder, with product heating effected through hot recirculated thermal fluid in the shaft, flighting and the trough. Positive considerations recommending equipment selection include the following:

- The equipment operation is relatively simple, and provides gentle handling of the conveyed material. Overall life of the equipment from a standpoint of abrasion appears to be good, based on discussions with references, and is substantially attributable to low rotative speed. References have indicated that maintenance due to abrasion is quite rare, even in services associated with refractory materials.

- Unlike other bidders, Holo-Flite has significant experience in coal drying applications and has developed a substantial database of information specific to coal. Additionally, of all bidders, Holo-Flite has the most operating units in service and the greatest number of years of design experience.

- Relatively minimal costs for Preliminary and Detailed Engineering indicate the standard nature of the equipment proposed for the application. No customization of design will be required, yielding confidence in Holo-Flites' experience in the equipment operation. No "one-of-a-kind" design is offered in the tender.

- Close evaluation of overall capital cost for equipment was not completed as no design optimization has been attempted. Therefore, the higher price of the Holo-Flite units was not a negative consideration in reviewing recommendation for award.

Consideration was given to the number of required Holo-Flite dryers (6) relative to the other tenders. However, this was deemed to be of lesser significance than other aspects of the proposed equipment as discussed herein, and therefore, not a deciding criteria. There will be higher costs associated with integration of the Holo-Flite equipment into the general arrangement, including more extensive coal feed systems, coal discharge gathering conveyor systems and thermal fluid piping and controls systems, though thorough quantitative evaluation of the additional requirements has not been made.

The important negative considerations relative to specification requirements and as compared to the offering by Holo-Flite for each tender is presented below:

3.1.1 Heyl & Patterson

Heyl & Patterson offered two (2) MultiDisc units for the coal drying application. The MultiDisc units are comprised of multiple rotating shafts mounted in a horizontal vessel, with the shafts oriented horizontally, perpendicular to the movement of the material. Multiple "Discs" are mounted on each shaft, which provide the motive impetus for material movement and material heating from hot oil circulating through each shaft and discs assembly. Negative considerations relative to the Holo-Flite tender include the following:

- Discussions with references indicated a minimal number of units in service, and particularly in coal service where only a single reference was supplied. The technology on which the equipment is based was reported to have changed hands a number of times over the past 15 years, and was primarily vested in the experience of the technology developer, Norbert Stevens.

- The offered equipment included the greatest number of rotary joints of all tenders at fifteen (15) per unit. In evaluation of all equipment configurations, rotary joints were judged to be a significant safety concern based on leakage of flammable thermal fluids, as well as an item of possibly significant maintenance requirements.

- Discussions with references indicated a requirement for replacement of keystock material movers mounted to each disc at approximately six (6) month intervals. Replacement was required due to erosion caused by abrasion from relatively high rotative speeds. It was estimated that maintenance work associated with this activity would require approximately two (2) days.

3.1.2 Hosokawa Bepex

Hosokawa Bepex (Bepex) offered one (1) screw conveyor type heat exchange unit, known as a TorusDisc. Material moves through the unit in the manner of screw conveyor, with product heating effected through hot recirculated thermal fluid in the shaft, flighting and the trough. Prior to initiation of bidding, based on work completed in the Conceptual Engineering phase of the project, it had been assumed that the equipment award would be issued to Bepex. This assumption was primarily based on the ability of Bepex to provide a single unit for the required throughput. However, evaluation versus other tenders recommended the award to Holo-Flite over Bepex. Negative considerations relative to the Holo-Flite tender include the following:

- The proposed equipment had the highest purchase price of other tenders by a significant margin.

- This proposed equipment required the highest operating horsepower of all tenders.

- Bepex indicated that the requested fabrication schedule was unattainable. Company engineering representatives indicated that projected fabrication shop loading would result in equipment fabrication delays of several months past the requested schedule.

- Bepex was significantly unresponsive to Request For Proposal requirements, especially those related to schedule and cost reporting. Bepex was approximately two (2) weeks overdue with their tender. Based on the schedule critical nature of the SynCoal facility design and construction, it was deemed that significant risk would be assumed in award of the work to Bepex.

4.0 Commercial Bid Analysis

Commercial bid analysis will be conducted as a separate document.

5.0 Conclusion

Based on the discussion herein, it is recommended that Holo-Flite be selected to conduct preliminary and detailed engineering for the Dryers. A request for costs associated with supply of the thermal fluid pumping system was provided in the Holo-Flite tender. Based on maintaining flexibility in design, it was deemed more appropriate to remove the associated items from this vendor supply, and perform design in the Detailed Engineering phase of the project. This would provide for the clearest interface with the heat exchanger supplier relative to performing equipment optimization exercises.

APPENDIX C-2

COOLER SELECTION DATA

WESTERN SYNCOAL COMPANY
CENTER SYNCOAL PRELIMINARY ENGINEERING

Bid Analysis and Recommendations

3rd Stage Coolers
Rev. 0. January 4. 1996

1.0 Summary and Recommendations

Three (3) vendors were contacted to supply bids for the 3rd Stage Coolers to be installed at the proposed Center SynCoal facility. Three (3) proposals were received, all of which were technically acceptable and sufficiently in compliance with the Specification criteria to warrant further conditioning.

The proposal from FMC provided advantages based on heavy construction, cost economy. simplicity of operation and user references. The Heyl & Patterson tender incorporating three (3) MultiDisc units (Option 3) was quite close for consideration. but the added complexity in design and the lack of common spare parts with the 1st Stage units recommended the selection of FMC.

2.0 Bid Summary

The 3rd Stage Coolers inquiry document was issued to three (3) vendors for bidding. All three (3) vendors contacted responded with acceptable quotations. The responses were organized into a bid tabulation form dated December 29, 1995, for further bid review and conditioning. Table 1 presents a cost summary of the bids received. less freight costs.

3.0 Technical Bid Analysis

Bids received were evaluated on a technical basis to determine strengths and weaknesses in key aspects of the proposal. The bid tabulation form included in this bid package provides a summary of the significant aspects of the proposals. This summary includes system construction. pricing. shipping and other information from the proposals.

The following section summarizes the most notable features and conclustions of the 3rd Stage Cooler bids.

Table 1
3rd Stage Coolers
Bid Summary

Manufacturer	Equipment Configuration	3rd Stage Coolers	
Heyl & Patterson (Option 1)	Three (3) Units: Rotary Tube Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$112.875 $225,750 $1,918.875 **$2,257,500**
Heyl & Patterson (Option 2)	Three (3) Units: Two (2) Rotary Tube (Coarse); One (1) MultiDisc (Fines)	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$90,175 $180,350 $1,532,975 **$1,803,500**
Heyl & Patterson (Option 3)	Three (3) Units: MultiDisc Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$53,600 $107,200 $911,200 **$1,072,000**
Holo Flight	Five (5) Units: Multiple Screw Conveyor Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$5.000 $15,000 $1.615.000 **$1,635,000**
FMC	Two (2) Units: Rotary Tube Configuration	Preliminary Engineering: Detailed Engineering: Equipment Fabrication: **Total Cost:**	$25.000 $92.000 $933.000 **$1,050,000**

3.1 3rd Stage Coolers

The inquiry documents issued for bid included a performance specification based on data from the current Mass and Energy Balance. No particular equipment configuration was specified: it was the intention of the performance bidding to allow each manufacturer to apply their expertise in design of heat transfer equipment for the application.

The recommendation for selection of the FMC equipment is based on heavy construction. cost economy, simplicity of operation and user references. The FMC rotary tube cooler consists of a horizontal cylindrical section with rectangular tubes running perpendicular to the movement of material. The cylinder sits partially immersed in a water bath, thereby achieving a high specific heat transfer surface area, combining the wall and internal tube surfaces. Positive considerations recommending equipment selection include the following:

- The equipment operation is very simple, and relatively gentle on the conveyed material, folding the material on itself. Overall life of the equipment from a standpoint of abrasion appears to be good, based on high drum surface area and periodic contact from material due to low rotative speed. This was confirmed in discussion with FMC references as detailed in the attached telephone log. Additionally, references have indicated excellent service life from rotating support equipment including trunnions and the drive.

- The equipment requires the lowest operating horsepower of all tenders. providing the lowest electrical power operating cost.

- The equipment operates at 80% heat transfer capacity at design conditions with the highest total heat transfer surface area, providing significant reported conservatism in design sizing relative to other tenders.

The 900RT30 units proposed by FMC have never been previously constructed for any application. However, following discussions with FMC, it appears that changes required for a unit of this size are minor, and no problems are anticipated.

The important negative considerations relative to specification requirements and as compared to the offering by FMC for each tender is presented below:

3.1.1 Heyl & Patterson

Option 1

Option 1 offered rotary tube heat exchangers somewhat similar in configuration to the FMC units. The Heyl & Patterson unit consists of a horizontal cylindrical vessel with circular cross-section tubes running parallel to the movement of material. Negative considerations relative to the FMC tender include the following:

- No immersion of the horizontal vessel is incorporated into equipment design and therefore the resulting overall heat transfer surface area is lower for units of overall dimensions comparable to FMC.

- This option has the highest purchase price of any other option or tender by a significant margin.

- This option required the highest operating horsepower of all tenders.

- The equipment operates at 95% heat transfer capacity at design conditions with the second highest total heat transfer surface area, providing the least significant reported conservatism in design sizing of all tenders.

Option 2

Option 2 offered a combination of two (2) MultiDisc units for the main product stream, with a single rotary tube unit for cooling of 2nd stage fines. The MultiDisk units are comprised of multiple rotating shafts mounted in a horizontal vessel, with the shafts oriented horizontally, perpendicular to the movement of the material. Multiple "Discs" are mounted on each shaft, which provide the motive impetus for material movement and material heating from hot oil circulating through each shaft and discs assembly. Negative considerations relative to the FMC tender include the following:

- The hybrid offering would provide two (2) different of equipment, introducing greater complexity to the design, operation and facility maintenance.

- This option required the second highest operating horsepower of all tenders.

- This option had the second highest price, by a significant margin to FMC, of all tenders.

Option 3

Option 3 offered three (3) MultiDisc units, with two (2) for the main product stream and one (1) for cooling of 2nd stage fines. Equipment construction is as described in Option 2. This option was evaluated in a short list format relative to FMC as offering many similar advantages. Equipment costs are almost identical to FMC and equipment references registered positive comments regarding the equipment. In the final evaluation, negative considerations relative to the FMC tender include the following:

- This option required 70 hp greater operating horsepower above FMC.

- Spare parts inventory would be different between the 1st Stage and Cooler equipment, yielding no associated economic advantage with single sourcing both equipment supplies.

- Unit operating is significantly more complex than that offered by FMC, including the requirement for rotary joints.

- Higher rotative speed, coupled with relatively small diameter discs will lead to greater abrasion/erosion potential.

- Greater number of units required would yield additional expense in materials feed and discharge equipment relative to the FMC equipment.

3.1.2 Holo Flight

Holo Flight offered five (5) screw conveyor type heat exchange units, each with four (4) internal screw conveyor assemblies. Material moves through the unit in the manner of a multiple screw feeder, with product cooling effected through water in the shaft, flighting and the trough. Negative considerations relative to the FMC tender include the following:

- This option has the second highest purchase price of other tenders by a significant margin.
- This option required the second highest operating horsepower of all tenders.
- Higher rotative speed, coupled with relatively small diameter flighting will lead to greater abrasion/erosion potential than the FMC equipment.
- Significantly greater number of units required would yield additional expense in materials feed and discharge equipment relative to the FMC equipment.

4.0 Commercial Bid Analysis

Commercial bid analysis will be conducted as a separate document.

5.0 Conclusion

Based on the discussion herein, it is recommended that FMC be selected to conduct preliminary and detailed engineering for the 3rd Stage Cooler.

APPENDIX C-3

HEAT EXCHANGER SELECTION DATA

WESTERN SYNCOAL COMPANY
CENTER SYNCOAL PRELIMINARY ENGINEERING

Bid Analysis and Recommendations

3rd Stage Coolers
Rev. 0. January 4. 1996

1.0 Summary and Recommendations

Three (3) vendors were contacted to supply bids for the 3rd Stage Coolers to be installed at the proposed Center SynCoal facility. Three (3) proposals were received, all of which were technically acceptable and sufficiently in compliance with the Specification criteria to warrant further conditioning.

The proposal from FMC provided advantages based on heavy construction, cost economy. simplicity of operation and user references. The Heyl & Patterson tender incorporating three (3) MultiDisc units (Option 3) was quite close for consideration. but the added complexity in design and the lack of common spare parts with the 1st Stage units recommended the selection of FMC.

2.0 Bid Summary

The 3rd Stage Coolers inquiry document was issued to three (3) vendors for bidding. All three (3) vendors contacted responded with acceptable quotations. The responses were organized into a bid tabulation form dated December 29, 1995, for further bid review and conditioning. Table 1 presents a cost summary of the bids received. less freight costs.

3.0 Technical Bid Analysis

Bids received were evaluated on a technical basis to determine strengths and weaknesses in key aspects of the proposal. The bid tabulation form included in this bid package provides a summary of the significant aspects of the proposals. This summary includes system construction. pricing. shipping and other information from the proposals.

The following section summarizes the most notable features and conclustions of the 3rd Stage Cooler bids.

Table 1
3rd Stage Coolers
Bid Summary

Manufacturer	Equipment Configuration	3rd Stage Coolers
Heyl & Patterson (Option 1)	Three (3) Units: Rotary Tube Configuration	Preliminary Engineering: $112.875 Detailed Engineering: $225,750 Equipment Fabrication: $1,918.875 **Total Cost: $2,257,500**
Heyl & Patterson (Option 2)	Three (3) Units: Two (2) Rotary Tube (Coarse); One (1) MultiDisc (Fines)	Preliminary Engineering: $90,175 Detailed Engineering: $180,350 Equipment Fabrication: $1,532,975 **Total Cost: $1,803,500**
Heyl & Patterson (Option 3)	Three (3) Units: MultiDisc Configuration	Preliminary Engineering: $53,600 Detailed Engineering: $107,200 Equipment Fabrication: $911,200 **Total Cost: $1,072,000**
Holo Flight	Five (5) Units: Multiple Screw Conveyor Configuration	Preliminary Engineering: $5,000 Detailed Engineering: $15,000 Equipment Fabrication: $1,615,000 **Total Cost: $1,635,000**
FMC	Two (2) Units: Rotary Tube Configuration	Preliminary Engineering: $25,000 Detailed Engineering: $92,000 Equipment Fabrication: $933,000 **Total Cost: $1,050,000**

3.1 3rd Stage Coolers

The inquiry documents issued for bid included a performance specification based on data from the current Mass and Energy Balance. No particular equipment configuration was specified: it was the intention of the performance bidding to allow each manufacturer to apply their expertise in design of heat transfer equipment for the application.

The recommendation for selection of the FMC equipment is based on heavy construction. cost economy, simplicity of operation and user references. The FMC rotary tube cooler consists of a horizontal cylindrical section with rectangular tubes running perpendicular to the movement of material. The cylinder sits partially immersed in a water bath, thereby achieving a high specific heat transfer surface area, combining the wall and internal tube surfaces. Positive considerations recommending equipment selection include the following:

- The equipment operation is very simple, and relatively gentle on the conveyed material. folding the material on itself. Overall life of the equipment from a standpoint of abrasion appears to be good, based on high drum surface area and periodic contact from material due to low rotative speed. This was confirmed in discussion with FMC references as detailed in the attached telephone log. Additionally, references have indicated excellent service life from rotating support equipment including trunnions and the drive.

- The equipment requires the lowest operating horsepower of all tenders. providing the lowest electrical power operating cost.

- The equipment operates at 80% heat transfer capacity at design conditions with the highest total heat transfer surface area, providing significant reported conservatism in design sizing relative to other tenders.

The 900RT30 units proposed by FMC have never been previously constructed for any application. However, following discussions with FMC, it appears that changes required for a unit of this size are minor, and no problems are anticipated.

The important negative considerations relative to specification requirements and as compared to the offering by FMC for each tender is presented below:

3.1.1 Heyl & Patterson

Option 1

Option 1 offered rotary tube heat exchangers somewhat similar in configuration to the FMC units. The Heyl & Patterson unit consists of a horizontal cylindrical vessel with circular cross-section tubes running parallel to the movement of material. Negative considerations relative to the FMC tender include the following:

- No immersion of the horizontal vessel is incorporated into equipment design and therefore the resulting overall heat transfer surface area is lower for units of overall dimensions comparable to FMC.

- This option has the highest purchase price of any other option or tender by a significant margin.

- This option required the highest operating horsepower of all tenders.

- The equipment operates at 95% heat transfer capacity at design conditions with the second highest total heat transfer surface area, providing the least significant reported conservatism in design sizing of all tenders.

Option 2
Option 2 offered a combination of two (2) MultiDisc units for the main product stream, with a single rotary tube unit for cooling of 2nd stage fines. The MultiDisk units are comprised of multiple rotating shafts mounted in a horizontal vessel, with the shafts oriented horizontally, perpendicular to the movement of the material. Multiple "Discs" are mounted on each shaft, which provide the motive impetus for material movement and material heating from hot oil circulating through each shaft and discs assembly. Negative considerations relative to the FMC tender include the following:

- The hybrid offering would provide two (2) different of equipment, introducing greater complexity to the design, operation and facility maintenance.

- This option required the second highest operating horsepower of all tenders.

- This option had the second highest price, by a significant margin to FMC, of all tenders.

Option 3
Option 3 offered three (3) MultiDisc units, with two (2) for the main product stream and one (1) for cooling of 2nd stage fines. Equipment construction is as described in Option 2. This option was evaluated in a short list format relative to FMC as offering many similar advantages. Equipment costs are almost identical to FMC and equipment references registered positive comments regarding the equipment. In the final evaluation, negative considerations relative to the FMC tender include the following:

- This option required 70 hp greater operating horsepower above FMC.

- Spare parts inventory would be different between the 1st Stage and Cooler equipment, yielding no associated economic advantage with single sourcing both equipment supplies.

- Unit operating is significantly more complex than that offered by FMC, including the requirement for rotary joints.

- Higher rotative speed, coupled with relatively small diameter discs will lead to greater abrasion/erosion potential.

- Greater number of units required would yield additional expense in materials feed and discharge equipment relative to the FMC equipment.

3.1.2 Holo Flight

Holo Flight offered five (5) screw conveyor type heat exchange units, each with four (4) internal screw conveyor assemblies. Material moves through the unit in the manner of a multiple screw feeder, with product cooling effected through water in the shaft, flighting and the trough. Negative considerations relative to the FMC tender include the following:

- This option has the second highest purchase price of other tenders by a significant margin.
- This option required the second highest operating horsepower of all tenders.
- Higher rotative speed, coupled with relatively small diameter flighting will lead to greater abrasion/erosion potential than the FMC equipment.
- Significantly greater number of units required would yield additional expense in materials feed and discharge equipment relative to the FMC equipment.

4.0 Commercial Bid Analysis

Commercial bid analysis will be conducted as a separate document.

5.0 Conclusion

Based on the discussion herein, it is recommended that FMC be selected to conduct preliminary and detailed engineering for the 3rd Stage Cooler.

Western Syncoal - Center Syncoal Plant
Gas Heating Heat Exchanger Bid Evaluation

Summary

Requests for bids for the above equipment were sent to a total of five bidders on February 28, 1997: Eco Inc. (Eco); Applied Thermal Systems Inc. (ATS); Yuba Heat Transfer; Rome-Turney Radiator Company; and, Aerofin Corporation. Three bids were received on the due date of March 14, 1997: Eco; ATS; and, Aerofin. The Aerofin bid was quickly eliminated due to price and technical nonconformance. The two remaining bidders, Eco and ATS, were evaluated.

Due to the project being transferred, this evaluation can not be completed to include an economic evaluation beyond first cost. Therefore, only a tentative recommendation can be made at this time. Stone and Webster tentatively recommends that the order be placed with Eco.

Technical

Attachment 1 is a spreadsheet showing the technical comparison of Eco and ATS. It can be seen that Eco conforms to the SWEC performance requirements. This has been confirmed by Eco. There are performance deviations in the ATS data.

ATS differs in performance on the reactor gas heating side. The reason given is due to shipping size constraints of the modules. The surface area distribution corresponding to the ideal shipping size causes more area than needed to be put into the desuperheating heater, HX-3611. This is not good for operation because some condensing would likely take place during normal operating conditions. Note, condensing will take place during startup in any case with any bidders equipment. This is considered permissible as long as adequate startup drains are used. Two cases were offered by ATS for these heaters: one which deviates so shipping constraints can be held; and, one which more nearly conforms to SWEC specifications . These are shown in Attachment 1, pages 4 and 5, as Base and Alternate respectively. Since the Alternate option more nearly conforms to SWEC requirements, it would be chosen over the Base. Even though the cost is higher, it is SWEC's judgement that fewer operating problems would be experienced with the greater degree of superheat exiting the desuperheating heater (HX-3611) with the Base design.

Eco has the following technical advantages over ATS:

1. Generally more surface area for heat transfer.

2. Lower steam side pressure losses which add a greater measure of conservatism to performance predictions of the overall system.

3. Greater conformance to the original specification thus minimizing changes to existing calculations and P&IDs.

4. Generally shorter lengths in the flow direction (upward). This allows somewhat more freedom in the vertical location of the heaters within the ductwork.

Economics

A detailed net present value analysis of the two contending bidders was not done by SWEC. A comparison of first costs is shown in Attachment 2. The Eco price is approximately $169,000 lower than the ATS Alternate offering. ATS's Alternate would be chosen over their Base because of technical reasons given above. Even if the Base were to be chosen, the cost difference would be approximately $100,000. The Aerofin bid price was approximately $1,798,000. The detailed cost analysis considering payment schedule, taxes, etc. must be done by others.

There are some technical details which must be resolved and may entail relatively small price increases. They are discussed below. Neither bidder quoted a price for a booster compressor for the nitrogen sootblowers.

Schedule

Both bidders are able to make the initial schedule presented to them which dictated a mid to late November 1997 delivery. Both were asked to investigate accomodating a mid-October delivery so these large pieces of equipment can be installed and the building enclosed before the onset of winter weather.

Eco states that to make this schedule, chrome-moly pipe must be ordered by April 15, 1997 and carbon steel pipe by May 1, 1997. ATS stated that they can make delivery with a purchase order date of April 15, 1997.

Technical Details Still to be Resolved

With the compliance of Western Syncoal, the recommended bidder should meet with the engineers to discuss various details of design at the soonest possible opportunity. These include but are necessarily limited to the following:

1. The inlet/outlet headers for heaters HX-3601, - 3611, and - 3612 may need to be modified to allow for two independantly isolable steam paths. This must be confirmed by means of steady state low load heat balance calculations.

2. To discuss support details, allowable forces and moments, and thermal movements on all major steam/water side and gas side connections.

3. To discuss instrumentation connections for performance verification and operational necessities.

4. Review materials including special hydrotest procedures for chrome-moly parts. These may be necessary for any hydrotesting which may occur years into operation because of transition temperature increase for this material with time.

5. Discussion of plant construction sequence so heat exchanger manufacturing and shipping sequence can be set.

6. Discussion of sootblowing requirements so the nitrogen booster compressor and nitrogen storage system can be designed.

Recommendation

The evaluation of which manufacturer should supply the heat exchangers for this project is not complete due to further economic considerations by others. However, based on what has been learned so far, a tentative recommendation can be made based on technical merit and first costs. That tentative recommendation is that Eco Inc. supply these heat exchangers.

Attach[illegible]t 1

Western Syncoal
Center Syncoal Plant
Gas Heating Heat Exchanger Technical Evaluation

HX Number and Description: HX-3601, Dryer Gas Heater - Condensing

Italicized Bidder values are calculated by SWEC

	Bidder	Units	Eco, Inc.			ATS, Inc.			SWEC Spec.
	Date Info Received/Revised/Reaffirmed		Mar 14,'97	Mar 17,'97	Mar 26,'97	Mar 14,'97	Mar 20,'97	Mar 26,'97	
1	Steam Tin	F	665	665	665	665	650	650	665
2	Steam Tout	F	648.78	648.78	648.78	650.2	635.4	635.4	648.78
3	Gas Tin	F	418.4	418.4	418.4	428.1	430.1	430.1	418.4
4	Gas Tout	F	550	550	550	550.1	550	550	550
5	Effective MTD	F	167.3	155	155	*153.08*	*153.08*	*153.08*	155.4
6	Heat Transfer Coefficient	Btu/Hr-SqFt-deg F	6.46	6.46	6.46	*8.17*	7.138	7.138	
7	Heat Transfer Area	Sq Ft	27171	29641	29641	21358	24918	24918	
8	Heat Transferred	MMBtu/Hr	29.36	29.36	29.36	26.45	26.45	26.45	29.36
9	*UxAxLMTD (5x6x7)*	MMBtu/Hr	*29.37*	*29.68*	*29.68*	*26.71*	*27.23*	*27.23*	
10	Steam Flow	Lb/Hr	63037	63037	63037	63037	63037	63037	63037
11	*Gas Flow*	Lb/Hr	469080	469080	469080	469080	469080	469080	469080
12	Steam Pressure Loss	Psid	6	7	7	15	15	15	10
13	Gas Pressure Loss	In H2O		1.35	1.35	5.8	5.42	5.42	15 w/3602's
14	Steam Side Design Pressure	Psig	2400	2400	2400	2400	2400	2400	2400
15	Steam Side Design Temperature	F	775	775	775	775	775	775	775
	Inlet Header:								
16	Diameter	In. Nominal				8	8	8	
17	Length	Ft-In				8-0	8-0	8-0	
18	Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	CS
	Outlet Header:								
19	Diameter	In. Nominal				8	8	8	
20	Length	Ft-In				8-0	8-0	8-0	
21	Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	CS
	Tubes:								
22	Diameter	In	2.375	2.375	2.375	2.38	2.38	2.38	
23	Thickness	In				.343 Ave	.343 Ave	.343 Ave	
24	Length	Ft-In	20-0	20-0	20-0	17-0	17-0	17-0	
25	Material		A106B	A106B	A106B	A106B	A106B	A106B	CS
26	Design Temperature	F				715	715	715	775
27	Transverse Number		34	34	34	24	24	24	
28	Transverse Spacing		4	4	4	4	4	4	
29	Longitudinal Rows		11	12	12	12	14	14	
30	Longitudinal Spacing		4	4	4	4	4.5	4.5	
31	Arrangement		Square	Square	Square	In-Line	In-Line	In-Line	
	Fins:								
32	Number per Inch		4	4	4	3	3	3	
33	Height	In	0.5	0.5	0.5	0.6875	0.6875	0.6875	
34	Thickness	In	*0.05*	*0.05*	*0.05*	0.075	0.075	0.075	
35	Material		CS	CS	CS	CS	CS	CS	
36	Type		Solid	Solid	Solid	Serrated	Serrated	Serrated	
37	Casing Material		CS	CS	CS	CS	CS	CS	
38	Casing Thickness	In.	0.375	0.375	0.375	*0.375*	*0.375*	*0.375*	
39	Shipping Weight	Lbs	110000	114000	114000	240000 Tot		105000	
40	Flooded Weight	Lbs	116000	122000	122000				
41	*Height (Along Flow)*	Ft-In	7-0	7-4	7-4	20-8 Tot		9-0	
42	Width	Ft-In	12-4	12-4	12-4	9-6		9-6	
43	Length	Ft-In	23-10	23-10	23-10	22-0		22-0	

Attach. .t 1

Western Syncoal
Center Syncoal Plant
Gas Heating Heat Exchanger Technical Evaluation

HX Number and Description: HX-3602A, Dryer Subcooling Heat Exchanger

Italicized Bidder values are calculated by SWEC

Bidder	Units	Eco, Inc.			ATS, Inc.			SWEC Spec.
Date Info Received/Revised/Reaffirmed		Mar 14 '97	Mar 17 '97	Mar 26 '97	Mar 14 '97	Mar 20 '97	Mar 26 '97	
1 Water Tin	F	648.12	648.12	648.12	648	648	648	648.12
2 Water Tout	F	380	380	380	363.8	359	359	380
3 Gas Tin	F	222	222	222	222	222	222	222
4 Gas Tout	F	418.4	418.4	418.4	423.3	426.9	426.9	418.4
5 Effective MTD	F	195.3	195.3	195.3	*180.08*	175.71	175.71	191.6
6 Heat Transfer Coefficient	Btu/Hr-SqFt-deg F	6.2	6.2	6.2	*6.62*	6.904	6.904	
7 Heat Transfer Area	Sq Ft	17436	17436	17436	17798	17798	17798	
8 Heat Transferred	MMBtu/Hr	21.18	21.18	21.18	21.23	21.23	21.23	21.18
9 *UxAxLMTD (5x6x7)*	MMBtu/Hr	*21.11*	*21.11*	*21.11*	*21.22*	*21.59*	*21.59*	
10 Water Flow	Lb/Hr	62866	62866	62866	62866	62866	62866	62866
11 Gas Flow	Lb/Hr	224455	224455	224455	235228	235000	235000	224455
12 Water Pressure Loss	Psid	10	10	10	12.2	13.5	13.5	20
13 Gas Pressure Loss	In H2O	1.5	1.5	1.5	6.86	6.12	6.12	15 w/3601
14 Water Side Design Pressure	Psig	2300	2300	2300	2300	2300	2300	2300
15 Water Side Design Temperature	F	675	675	675	675	675	675	675
Inlet Header:								
16 Diameter	In. Nominal				8	8	8	
17 Length	Ft-In				4-0	4-0	4-0	
18 Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	CS
Outlet Header:								
19 Diameter	In. Nominal				8	8	8	
20 Length	Ft-In				4-0	4-0	4-0	
21 Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	CS
Tubes:								
22 Diameter	In	2.375	2.375	2.375	2.38	2.38	2.38	
23 Thickness	In				.343 Ave	.343 Ave	.343 Ave	
24 Length	Ft-In	20	20	20	17-0	17-0	17-0	
25 Material		A106B	A106B	A106B	A106B	A106B	A106B	CS
26 Design Temperature	F				675	675	675	675
27 Transverse Number		16	16	16	12	12	12	
28 Transverse Spacing		4	4	4	4	4	4	
29 Longitudinal Rows		15	15	15	20	20	20	
30 Longitudinal Spacing		4	4	4	4	4.5	4.5	
31 Arrangement		Square	Square	Square	In-Line	In-Line	In-Line	
Fins:								
32 Number per Inch		4	4	4	3	3	3	
33 Height	In	*0.5*	*0.5*	*0.5*	0.6875	0.6875	0.6875	
34 Thickness	In	0.05	0.05	0.05	0.075	0.075	0.075	
35 Material		CS	CS	CS	CS	CS	CS	
36 Type		Solid	Solid	Solid	Serrated	Serrated	Serrated	
37 Casing Material		CS	CS	CS	CS	CS	CS	
38 Casing Thickness	In.	0.375	0.375	0.375	0.375	0.375	0.375	
39 Shipping Weight	Lbs	140000Incl B	140000Incl B	140000Incl B	240000 Tot		140000Incl B	
40 Flooded Weight	Lbs	150000Incl B	150000Incl B	150000Incl B				
41 Height (Along Flow)	Ft-In	8-4	8-4	8-4	20-8 Tot		12-6	
42 Width	Ft-In	12-4 Incl B	12-4 Incl B	12-4 Incl B	9-6		9-6	
43 Length	Ft-In	23-10	23-10	23-10	22-0		22-0	

Attachment 1

Western Syncoal
Center Syncoal Plant
Gas Heating Heat Exchanger Technical Evaluation

HX Number and Description: HX-3602B, Reactor Subcooling Heat Exchanger

Italicized Bidder values are calculated by SWEC

Bidder	Units	Eco, Inc.			ATS, Inc.			SWEC Spec.
Date Info Received/Revised/Reaffirmed		Mar 14,'97	Mar 17,'97	Mar 26,'97	Mar 14,'97	Mar 20,'97	Mar 26,'97	
1 Water Tin	F	642.75	642.75	642.75	648	642	642	642.75
2 Water Tout	F	380	380	380	383.7	376.7	376.7	380
3 Gas Tin	F	222	222	222	222	222	222	222
4 Gas Tout	F	418.4	418.4	418.4	433	433.4	433.4	418.4
5 Effective MTD	F	*189.2*	191.1	191.1	*187.1*	180.3	180.3	189.2
6 *Heat Transfer Coefficient*	*Btu/Hr-SqFt-deg F*	6.1	6.1	6.1	*6.62*	6.929	6.929	
7 Heat Transfer Area	Sq Ft	19615	19615	19615	17798	17798	17798	
8 Heat Transferred	MMBtu/Hr	23.09	23.09	23.09	22.13	22.13	22.13	23.09
9 *UxAxLMTD (5x6x7)*	MMBtu/Hr	*22.64*	*22.87*	*22.87*	*22.04*	*22.24*	*22.24*	
10 Water Flow	Lb/Hr	70461	70461	70461	70461	70461	70461	70461
11 Gas Flow	Lb/Hr	244625	244625	244625	233795	234080	234080	244625
12 Water Pressure Loss	Psid	10	10	10	15.3	17	17	20
13 Gas Pressure Loss	In H2O	1.5	1.5	1.5	6.84	6.11	6.11	15 w/3601
14 Water Side Design Pressure	Psig	2300	2300	2300	2300	2300	2300	2300
15 Water Side Design Temperature	F	675	675	675	675	675	675	675
Inlet Header:								
16 Diameter	In. Nominal				8	8	8	
17 Length	Ft-In				4-0	4-0	4-0	
18 Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	CS
Outlet Header:								
19 Diameter	In. Nominal				8	8	8	
20 Length	Ft-In				4-0	4-0	4-0	
21 Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	CS
Tubes:								
22 Diameter	In	2.375	2.375	2.375	2.38	2.38	2.38	
23 Thickness	In				.343 Ave	.343 Ave	.343 Ave	
24 Length	Ft-In	20	20	20	17-0	17-0	17-0	
25 Material		A106B	A106B	A106B	A106B	A106B	A106B	CS
26 Design Temperature	F				675	675	675	675
27 Transverse Number		18	18	18	12	12	12	
28 Transverse Spacing		4	4	4	4	4	4	
29 Longitudinal Rows		15	15	15	20	20	20	
30 Longitudinal Spacing		4	4	4	4	4.5	4.5	
31 Arrangement		Square	Square	Square	In-Line	In-Line	In-Line	
Fins:								
32 Number per Inch		4	4	4	3	3	3	
33 Height	In	0.5	0.5	0.5	0.6875	0.6875	0.6875	
34 Thickness	In	0.05	0.05	0.05	0.075	0.075	0.075	
35 Material		CS	CS	CS	CS	CS	CS	
36 Type		Solid	Solid	Solid	Serrated	Serrated	Serrated	
37 Casing Material		CS	CS	CS	CS	CS	CS	
38 Casing Thickness	In.	0.375	0.375	0.375	0.375	0.375	0.375	
39 Shipping Weight	Lbs	140000Incl A	140000Incl A	140000Incl A	240000 Tot		140000 InclA	
40 Flooded Weight	Lbs	150000Incl A	150000Incl A	150000Incl A				
41 Height (Along Flow)	Ft-In	8-4	8-4	8-4	20-8 Tot		12-6	
42 Width	Ft-In	12-4 Incl A	12-4 Incl A	12-4 Incl A	9-6		9-6	
43 Length	Ft-In	23-10	23-10	23-10	22-0		22-0	

Attachment 1

Western Syncoal
Center Syncoal Plant
Gas Heating Heat Exchanger Technical Evaluation

HX Number and Description: HX-3611, Reactor Gas Heater - Desuperheating

Italicized Bidder values are calculated by SWEC

Bidder	Units	Eco, Inc.			ATS, Inc.					SWEC Spec.
Date Info Received/Revised/Reaffirmed		Mar 14,'97	Mar 17,'97	Mar 26,'97	Mar 14,'97	Mar 20,'97 Base	Mar 20,'97 Alternate	Mar 26,'97 Base	Mar 26,'97 Alternate	
1 Steam Tin	F	989	989	989	989	989	989	989	989	989
2 Steam Tout	F	680	680	680	678.8	651.2	667.6	651.2	667.6	680
3 Gas Tin	F	635.33	635.33	635.33	630.4	608.4	624.2	608.4	624.2	635.33
4 Gas Tout	F	750	750	750	750	750	750	750	750	750
5 Effective MTD	F	*115.87*	111.9	111.9	*119.35*	114.2	114.6	114.2	114.6	115.87
6 Heat Transfer Coefficient	Btu/Hr-SqFt-deg F	5.45	5.45	5.45	*5.43*	*5.964*	*5.917*	*5.964*	*5.917*	
7 Heat Transfer Area	Sq Ft	29641	29641	29641	28477	32037	28477	32037	28477	
8 Heat Transferred	MMBtu/Hr	18.08	18.08	18.08	18.47	18.47	18.47	18.47	18.47	18.08
9 *UxAxLMTD (5x6x7)*	MMBtu/Hr	*18.72*	*18.08*	*18.08*	*18.46*	*21.82*	*19.31*	*21.82*	*19.31*	
10 Steam Flow	Lb/Hr	68124	68124	68124	68124	68124	68124	68124	68124	68124
11 Gas Flow	Lb/Hr	322180	322180	322180	322180	322180	322180	322180	322180	322180
12 Steam Pressure Loss	Psid	22	22	22	40.2	44.1	39.9	44.1	39.9	50
13 Gas Pressure Loss	In H2O	1	1	1	5.18	4.63	4.16	4.63	4.16	15 w/3612
14 Steam Side Design Pressure	Psig	2400	2400	2400	2400	2400	2400	2400	2400	2400
15 Steam Side Design Temperature	F	1005	1005	1005	1005	1005	1005	1005	1005	1005
Inlet Header:										
16 Diameter	In. Nominal				8	8	8	8	8	
17 Length	Ft-In				8-0	8-0	8-0	8-0	8-0	
18 Material		SA335-P22	SA335-P22	SA335-P22	SA335-P22	SA335-P22	SA335-P22	SA335-P22	SA335-P22	Cr-Mo
Outlet Header:										
19 Diameter	In. Nominal				8	8	8	8	8	
20 Length	Ft-In				8-0	8-0	8-0	8-0	8-0	
21 Material					SA106C	SA106C	SA106C	SA106C	SA106C	
Tubes:										
22 Diameter	In	2.375	2.375	2.375	2.38	2.38	2.38	2.38	2.38	
23 Thickness	In				.343 & .436	.343 & .436	.343 & .436	.343 & .436	.343 & .436	
24 Length	Ft-In	20-0	20-0	20-0	17-0	17-0	17-0	17-0	17-0	
25 Material		SA335-P22	SA335-P22	SA335-P22	A106C,P11&P22	A106C,P11&P22	A106C,P11&P22	A106C,P11&P22	A106C,P11&P22	Cr-Mo
26 Design Temperature	F				1005	1005	1005	1005	1005	
27 Transverse Number		34	34	34	24	24	24	24	24	
28 Transverse Spacing		4	4	4	4	4	4	4	4	
29 Longitudinal Rows		12	12	12	16	16	16	16	16	
30 Longitudinal Spacing		4	4	4	4	5	5	5	5	
31 Arrangement		Square	Square	Square	In-Line	In-Line	In-Line	In-Line	In-Line	
Fins:										
32 Number per Inch		4	4	4	3	3	3	3	3	
33 Height	In	0.5	0.5	0.5	0.6875	0.6875	0.6875	0.6875	0.6875	
34 Thickness	In	0.05	0.05	0.05	0.075	0.075&0.06	0.075&0.06	0.075&0.06	0.075&0.06	
35 Material		409SS/CS	409SS/CS	409SS/CS	CS	CS	CS	CS	CS	
36 Type		Solid	Solid	Solid	Serrated	Serrated	Serrated	Serrated	Serrated	
37 Casing Material		CS	CS	CS	CS	Corten	Corten	Corten	Corten	
38 Casing Thickness	In.	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	
39 Shipping Weight	Lbs	115000	115000	115000	315000 Tot			170000	170000	
40 Flooded Weight	Lbs	123000	123000	123000						
41 Height (Along Flow)	Ft-In	7-4	7-4	7-4	26-4 Tot			10-6	10-6	
42 Width	Ft-In	12-4	12-4	12-4	9-6			9-6	9-6	
43 Length	Ft-In	23-10	23-10	23-10	22-0			22-0	22-0	

Attach....nt 1

Western Syncoal
Center Syncoal Plant
Gas Heating Heat Exchanger Technical Evaluation

HX Number and Description: HX-3612, Reactor Gas Heater - Condensing

Italicized Bidder values are calculated by SWEC

Bidder	Units	Eco, Inc.			ATS, Inc.					SWEC Spec.
Date Info Received/Revised/Reaffirmed		Mar 14,'97	Mar 17,'97	Mar 26,'97	Mar 14,'97	Mar 20,'97 Base	Mar 20,'97 Alternate	Mar 26,'97 Base	Mar 26,'97 Alternate	
1 Steam Tin	F	660	660	660	660	644	644	644	644	660
2 Steam Tout	F	643.43	643.43	643.43	647.2	632.3	631.3	632.3	631.3	643.43
3 Gas Tin	F	415	415	415	415	415	415	415	415	415
4 Gas Tout	F	635.33	635.33	635.33	630.4	608.4	624.2	608.4	624.2	635.33
5 Effective MTD	F	*66*	75.72	*66*	*82*	*87.5*	82.4	*87.5*	82.4	66
6 Heat Transfer Coefficient	Btu/Hr-SqFt-deg F	5.97	5.85	6.5	*7.9*	*6.32*	*6.32*	*6.32*	*6.32*	
7 Heat Transfer Area	Sq Ft	61752	76573	79043	49836	46276	60515	46276	60515	
8 Heat Transferred	MMBtu/Hr	33.92	33.92	33.92	32.29	32.29	31.35	32.29	31.35	33.92
9 UxAxLMTD (5x6x7)	MMBtu/Hr	*24.33*	*33.92*	*33.91*	*32.28*	*25.59*	*31.51*	*25.59*	*31.51*	
10 Steam Flow	Lb/Hr	70645	70645	70645	70645	68124	70645	68124	70645	70645
11 Gas Flow	Lb/Hr	322180	322180	322180	322180	322180	322180	322180	322180	322180
12 Steam Pressure Loss	Psid	8.8	10.9	11.2	20	20	20	20	20	10
13 Gas Pressure Loss	In H2O	2.15	2.4	2.5	7.11	5.26	6.91	5.26	6.91	15 w/3611
14 Steam Side Design Pressure	Psig	2300	2300	2300	2300	2300	2300	2300	2300	2300
15 Steam Side Design Temperature	F	775	775	775	775	775	775	775	775	775
Inlet Header:										
16 Diameter	In. Nominal				8	8	8	8	8	
17 Length	Ft-In				8-0	8-0	8-0	8-0	8-0	
18 Material		A106B	A106B	A106B	SA106C	SA106C	SA106C	SA106C	SA106C	CS
Outlet Header:										
19 Diameter	In. Nominal				8	8	8	8	8	
20 Length	Ft-In				8-0	8-0	8-0	8-0	8-0	
21 Material					SA106C	SA106C	SA106C	SA106C	SA106C	
Tubes:										
22 Diameter	In	2.375	2.375	2.375	2.38	2.38	2.38	2.38	2.38	
23 Thickness	In				0.343	0.343	0.343	0.343	0.343	
24 Length	Ft-In	20-0	20-0	20-0	17-0	17-0	17-0	17-0	17-0	
25 Material		SA106B	SA106B	SA106B	SA106B	SA106B	SA106B	SA106B	SA106B	CS
26 Design Temperature	F				775	775	775	775	775	
27 Transverse Number		34	34	34	24	24	24	24	24	
28 Transverse Spacing		4	4	4	4	4	4	4	4	
29 Longitudinal Rows		25	31	32	28	26	34	26	34	
30 Longitudinal Spacing		4	4	4	4	4	4.5	4	4.5	
31 Arrangement		Square	Square	Square	In-Line	In-Line	In-Line	In-Line	In-Line	
Fins:										
32 Number per Inch		4	4	4	3	3	3	3	3	
33 Height	In	0.5	0.5	0.5	0.6875	0.6875	0.6875	0.6875	0.6875	
34 Thickness	In	0.05	0.05	0.05	0.075	0.075	0.075	0.075	0.075	
35 Material		CS	CS	CS	CS	CS	CS	CS	CS	
36 Type		Solid	Solid	Solid	Serrated	Serrated	Serrated	Serrated	Serrated	
37 Casing Material		CS	CS	CS	CS	CS	CS	CS	CS	
38 Casing Thickness	In.	0.375	0.375	0.375	0.375	0.375	0.375	0.375	0.375	
39 Shipping Weight	Lbs	241000	287000	294000	315000 Tot			180000	180000	
40 Flooded Weight	Lbs	258000	307000	315000						
41 Height (Along Flow)	Ft-In	15-0	17-0	17-4	26-4 Tot			14-6	14-6	
42 Width	Ft-In	12-4	12-4	12-4	9-6			9-6	9-6	
43 Length	Ft-In	23-10	23-10	23-10	22-0			22-0	22-0	

Attachment 2

Western Syncoal
Center Syncoal Plant
Gas Heating Heat Exchanger Price Tabulation

Bidder: Eco Inc.

(Pricing Current as of 3/27/97)

HX Number	Initial Price Mar 14,'97	Adjustments Mar 17,'97	Total for Each HX
HX-3601	197,440	13,575	211,015
HX-3602 A & B	256,125	0	256,125
HX-3611	291,960	0	291,960
HX-3612	448,435	65,260	513,695
Total for HX's	1,193,960	78,835	1,272,795
Sootblowers	78,000	---	78,000
Estimated Freight	49,725	---	49,725
Total	1,321,685	---	1,400,520 *

Bidder: Applied Thermal Systems, Inc.

(Pricing Current as of 3/27/97)

	Initial Price Mar 14,'97	Base Price Mar 20,'97	Alternate Price Mar 20,'97
Total for All Heat Exchangers Including Sootblowers	1,379,850	1,404,900	1,473,600
Estimated Freight	96,000	96,000	96,000
Total	1,475,850	1,500,900	1,569,600 *

* Prices for Comparison

APPENDIX C-4

SYNCOAL® TRANSPORT AND FEED SYSTEM

DRAFT

COPY

STONE & WEBSTER ENGINEERING CORPORATION

cc:	RS Unks 1/1	GR Todd 1/1
	GS Webster 1/1	KC Hanzon 1/1
	RM Houston 1/1	Chron File R2.2.1.1/0
	MJ Lidinsky 1/1	

March 28, 1997
SWEC J.O. No. 07063.01
Letter No. ________

Mr. Ray Sheldon
Western Syncoal Company
P.O. Box 7137
490 N. 31st St., Suite 308
Billings, MT 59103

LETTER OF RECOMMENDATION
SYNCOAL PNEUMATIC CONVEYING SYSTEMS
CENTER SYNCOAL PROJECT
MILTON R. YOUNG STATION
WESTERN SYNCOAL COMPANY

Dear Mr. Sheldon:

Stone & Webster has evaluated bids received in response to the request for proposal for the Western Syncoal Plant Pneumatic Conveying Systems Contract. Bid packages were submitted by Smoot Company, Delta Ducon Company, Fuller Kovako, and Air-Cure Incorporated.

Based upon the results of our technical evaluation and the lowest comparable direct costs for the scope of work defined in Western Syncoal Specification LS-685-010, Revision 0, Stone & Webster recommends that Smoot Company be awarded the contract, inclusive with the options shown in Attachment 1. This recommendation is contingent upon Western Syncoal Company successfully negotiating commercial terms and conditions, obtaining agreement on the schedule, and establishing a mutually agreed upon understanding on performance guarantees with Smoot Company.

The following summarizes the original total base bid prices received from each bidder:

	Smoot Company	Delta Ducon	Fuller Kovako	Air-Cure Inc.
Firm Lump Sum Price	$984,432	$1,306,109	$1,301,460[1]	$1,525,722
Cost Difference	Base	$ 321,677	$ 317,028	$ 541,290
Percent Difference	----	32.7%	32.2%	55.0%

(1) Original price received from Fuller Kovako is not firm.

DRAFT

After a thorough review of the original bids received, questions were sent to each bidder to obtain further clarifications, missing information, and alternate pricing. This step was necessary to ensure that each bidder's proposal was in full compliance with specification requirements, and to establish a common basis for comparison.

Because of the large differential in price between Air-Cure and the other bidders, a decision was made to eliminate Air-Cure and continue negotiations with Smoot, Delta Ducon and Fuller Kovako.

Attachment 1, Part D, summarizes each bidder's final revised proposal based on the information and changes requested at the preaward meetings, and the subsequent list of additional questions sent on March 23, 1997. For convenience, the revised total lump sum bid prices from Attachment 1, Part D, have been repeated below. Estimated costs for options and alternates regarding Fuller Kovako are shown with an asterisk.

	Smoot Company	Delta Ducon	Fuller Kovako
Total Lump Sum Price	$1,161,135	$1,242,486	$1,307,578
Cost Difference	Base	$ 81,351	$ 146,443
Percent Difference	----	7%	12.6%

Preaward Meetings

At the preaward meetings each bidder's proposal was reviewed in detail. The major topics discussed are shown in outline form in Attachment 2. It should be noted that representatives from Western Syncoal and Unifield Engineers were not available to attend any of the meetings. Therefore, all discussions were confined to technical issues and schedule. All information requested during the preaward meetings and subsequently by FAX has been received. Copies of responses are included with each bidder's proposal in Attachment 3.

Adjustments and Options

Item C of Attachment 1 shows a breakdown of the various adjustments and options that have been incorporated into each bidder's proposal based on the specification, the preaward meeting, and Stone & Webster's understanding of the project requirements. Item D shows that final total lump sum prices which includes design of the surge bins, recommended design of the outlets at the Synfuel storage bins, and elimination of all PLC equipment and programming from the Supplier's scope of work. Each bidder has agreed to provide a written sequence of operation for their equipment.

DRAFT

Schedule

All three remaining bidders have provided a schedule for the work, with the understanding that they will be authorized to proceed with engineering prior to final contract agreement. The required milestone schedule dates given to each bidder are as follows:

	Start	Complete
Award Contract	-----	4/1/97
Submit Approval Drawings	5/1/97	6/1/97
Fab & Deliver Equipment	6/1/97	10/1/97

Smoot Company has indicated a delivery of 20 to 24 weeks following confirmation of all technical points. This time period falls within the major milestone dates listed above. They have also indicated a willingness to work with Western Syncoal and adjust their schedule to meet the required delivery dates, if necessary.

Guarantees

All three bidders have provided a written system guarantee which stipulated requirements. Fuller Kovako's guarantee is the most restrictive. Smoot and Delta Ducon will provide similar guarantees that are less restrictive. Stone & Webster recommends that Western Syncoal carefully review the preferred bidder's guarantee for acceptability, and obtain any changes in writing prior to award.

Summary

Based upon the technical evaluation and lowest total evaluated cost. Stone & Webster recommends that final negotiations be initiated with Smoot Company, on the basis of the adjusted final lump sum bid price shown in Attachment 1, Item D, to design and furnish the Syncoal Pneumatic Conveying Systems at the Milton R. Young Station.

If you have any questions, please contact me at (303) 741-7013.

Sincerely,

Gordon S. Webster
Project Engineer

Attachments

FILE : PNEUSYS1

ATTACHMENT 1

BID SUMMARY
PNEUMATIC CONVEYING SYSTEMS
CENTER SYNCOAL PROJECT
MILTON R. YOUNG STATION

07063.01
28-Mar-97
1 OF 1
REV. 0

ITEM / DESCRIPTION	SMOOT CO.	DELTA DUCON	FULLER KOVAKO	AIR - CURE CO.
A. ORIGINAL PROPOSAL	$984,432 2 - 17 -97	$1,306,109 2 - 17 -97	$1,301,460 * 2 - 28 -97	$1,525,722 2 - 17 -97
COST DIFFERENCE	BASE	$321,677	$317,028	$541,290
B. REVISED PROPOSAL	$1,159,205 3 - 19 -97	$1,306,109 3 - 19 -97	$1,284,611 3 - 18 -97	NOT EVALUATED
C. OPTIONS & ALTERNATES				FURTHER
DEDUCT FOR PNEUMATIC PIPING	($59,600)	($82,897)	INCLUDED	
GRAVITY FEED FROM UNIT 1 SURGE BINS	INCLUDED	INCLUDED	INCLUDED	
S. S. *INJECTION FITTINGS IN COAL FEED LINES*	$17,330	$12,214	$15,000 **	
DESIGN OF SURGE BINS	INCLUDED	INCLUDED	$27,144	
DESIGN OF DISCHARGE AT SYNFUEL BINS	$4,200	INCLUDED	INCLUDED	
COMMON MANIFOLD FOR (3) PNEUMATIC BLRS.	INCLUDED	$7,060	INCLUDED	
S. S. FLIGHTS & SHAFTS FOR SCREW FEEDERS	INCLUDED	INCLUDED	INCLUDED	
MANUAL SHUT - OFF GATES ABOVE AIRLOCKS	INCLUDED	INCLUDED	INCLUDED	
WRITTEN DESCRIPTION OF SYSTEM CONTROLS	INCLUDED	INCLUDED	INCLUDED	
STARTUP ASSISTANCE	NOT INCLUDED	NOT INCLUDED	NOT INCLUDED	
BLOWER SOUND ENCLOSURES	$40,000	INCLUDED	$40,000 **	
DEDUCT FOR CONTROLS SYSTEM EQUIPMENT	INCLUDED	INCLUDED	($60,000) **	
DEDUCT FOR ROTARY AIRLOCK FEEDERS	N / A	N / A	($48,211)	
WEARBACK ELBOWS W / TANGENT PIECE	INCLUDED	INCLUDED	$49,034	
SUB TOTAL	$1,930	($63,623)	$22,967	
D. REVISED LUMP SUM PRICE (ITEMS B + C) — TOTAL COST	$1,161,135	$1,242,486	$1,307,578	N / A
COST DIFFERENCE	BASE	$81,351	$146,443	
% DIFERENCE	-----	7.0%	12.6%	

NOTES

* INITIAL PRICE PROVIDED BY FULLER KOVAKO IS NOT FIRM.

** INDICATES ESDSTIMATED PRICE.

ATTACHMENT 2

CENTER SYNCOAL PROJECT
MILTON R. YOUNG STATION
PNEUMATIC CONVEYING SYSTEMS

PREAWARD MEETING
TOPICS OF DISCUSSION

1. A brief history of your company's experience regarding pneumatic conveying of the same or similar materials.

2. Scope of supply.

3. Proposed method of control of the system to feed coal to the surge bins and into the boiler.

4. How accuracy of feed rate and turn down of system will be accomplished.

5. Physical Space requirements for your equipment at the Syncoal bin area and inside the existing power plant.

6. Method of tie-in into the existing coal feed lines on both Unit 1 and 2 boilers.

7. Reliability of system components for this application.

8. Performance Guarantees.

9. Schedule.

ATTACHMENT 3

PROPOSAL DATA

APPENDIX D

SITE SPECIFIC ENGINEERING STUDIES

APPENDIX D-1

ACCP TEST DATA

TEST RESULTS '93

Western SynCoal Company
MEMORANDUM

TO: Jim Kelly
FROM: Art Viall
DATE: November 2, 1993
c: Bill Ruzynski, Ray Sheldon, Cliff Groombridge, Jeff Richards
Brad Nelson, Tom Rossetto, Test File 9336
SUBJECT: Final Test Report - DEMO9336 - BNI Lignite.

ABSTRACT

The ACCP facility successfully processed about 532 tons of BNI lignite on September 20, 1993. The product from the BNI lignite feedstock contained about 7.4% moisture and had a heating value of 10,799 BTU/lb (53% increase). The product contained about 0.77% sulfur (1.43 lb SO_2/MM BTU) which represented a 53% reduction on a MMBTU basis.

The product (192 tons) from the test was shipped back to Center, ND for a test burn at the MRY station. The composite process fines where also shipped to Center ND for a handling test.

The change in raw coal feedstock was made on-line with no interruption of coal feed to the process. The process was switched back to Rosebud coal at the end of the test, again without interruption of coal feed to the process. Very good control of the process was maintained throughout the test.

TEST OBJECTIVES

The objectives for this test were:

1. Determine the effectiveness of the ACCP Demonstration plant on BNI lignite.
2. Produce sufficient quantities of processed lignite and lignite process fines to perform preliminary testing at Minnkota's power stations in Center, ND.
3. Determine a mass balance for lignite in the ACCP process.
4. Determine lignite process dust characteristics.

PLANT CONFIGURATION

The plant was configured for duel train operation.

The processed product was conveyed off C-13 which is a temporary conveyor, to facilitate filling product transport trucks.

TEST CONDUCT (as accomplished)

A copy of the signed-off test procedure as conducted is included in the test file.

The ACCP plant was at normal operating conditions. The surge bins were filled to 90% with Rosebud coal while the 1000 ton raw coal storage bin, T-91, was allowed to run out. At a predetermine time, the infeed was completely cleared of Rosebud coal, T-91 was allowed to completely empty, and the gate feeding the process surge bins, G-32, was closed. The BNI lignite which had been stockpiled over a two week period, was fed into the infeed hopper, screened, and loaded into T-91.

Once the screening of BNI lignite commenced, there was no feed to the surge bins and they began drawing down as the Rosebud coal was fed to the drying system. When levels dropped to about 10% the BNI lignite was fed to the surge bins. When the surge bin levels read 10%, about 20 ton of coal remains in the cone of the bin, so for about an hour a blend of increasing BNI lignite and decreasing Rosebud coal was fed to the process.

Because of the blending, the effect of the BNI lignite entering the process was very slow to develop. About 45 minutes after the first BNI lignite was fed to the process, the discharge temperatures from the first stage dryers were increasing and the discharge temperatures from the second stage dryers were decreasing. Two relatively minor adjustments were made to bring the process to normal operating conditions. The first stage dryer weirs were raised from 20° to 50° with the intent of holding the coal longer in the first stage dryer and increasing the heat transfer efficiency. At the same time, the natural gas flow rate was increased by about 15%.

About 75 minutes after initiating the lignite feed, the process was stable and loading of the product transport trucks was initiated. Sampling commenced after steady state conditions were obtained and continued throughout the test. The infeed rate averaged 32.1 TPH throughout the test. The product recovery rate averaged 12.4 TPH throughout the test or about 38.6% recovery.

About two hours after initiating the lignite feed, the fines handling system was diverted to T-90 to begin stockpiling fines. The fines handling system operated satisfactorily for the test. The fines cooler had some problems with pluggage similar to those experienced with the Rosebud feedstock. The separate fines streams were measured to determine the percentage of fines produced in each stage of the drying and cleaning process. The composite fines production rate was measured at 3.7 TPH or 11.5% of the infeed rate.

The effect of the change in feedstock on the cleaning system was noticeable during the test. The BNI lignite product is lighter than the rosebud product. The two mid size fraction stoners required adjustment to allow more material over the reject end. Very little pyrite was visible in the three minus 1/2" fractions. It appeared that the majority of the sulfur and ash removal was occurring in the plus

1/2" separator. The waste stream rate was probably 25 to 50% higher than could be obtained with an optimized system. The average waste production rate was 4.1 TPH or 12.8% of the infeed rate.

The process was stable and required only minor adjustments for about eight hours. Some process upsets were experienced about 2/3 through the test. Over a two hour period, second stage dryer discharge temperatures had a tendency to increase requiring process adjustment. This upset was probably a result of either a variable feed size distribution or pluggage of the infeed rotary air locks.

When T-91 had been emptied of BNI lignite, the surge bins were allowed to draw down to 10% before refilling with Rosebud coal. The process was returned to Rosebud coal feedstock with minimal adjustments.

OBSERVATIONS AND RESULTS

ACCP Process Conditions

The plant responded very well throughout the test.

While processing BNI lignite, the process mass balance shifted slightly from the Rosebud feedstock, producing less product and more vaporized water. An unexpected result was a decrease in the percentage of the infeed reporting to fines. The fines production was less than the previous BNI Lignite test and even less than from Rosebud feedstock. About 38.6% of the BNI lignite in-feed rate was recovered as product compared to about 53% with Rosebud feedstock. About 11.4% of the in-feed rate was produced as dust compared to about 15% with Rosebud feedstock. Table 1 contains the mass balance data from the test.

Table 1 - 9336 Mass Balance

Stream	Flow Rate (TPH)	Percent of Infeed Rate	Comment
Infeed	32.1	100	Based on total tonnage across the infeed weigh-belt and the duration between switching to BNI lignite and switching back to Rosebud
Product	12.4	38.6	Truck measurement
Fines	3.7	11.4	Truck measurement
Waste	4.1	12.8	Truck measurement
Vaporized Water	10.5	32.7	Calculated
Unaccounted	1.4	4.4	By Difference

The largest adjustment made to the process was an increase in natural gas firing rate. Data sheets from the Plant Control System typical of the process when feeding both BNI lignite and Rosebud coal are attached. The remainder of the data sheets, a copy of the operations log, and truck weigh tickets for the raw coal and product coal trucks are located in the test file.

Gas analysis was performed during the test on first and second stage drying gas and the cooling gas. First stage gas chemistry and cooler gas chemistry was substantially unaffected by the change in feedstock. This is not unexpected because the first stage chemistry is held steady by the combustion gases from the furnace. The cooler gas chemistry is also relatively unaffected by feedstock due to a first stage gas purge into the cooler loop and because very little chemistry occurs in the cooler loop. The second stage chemistry did show some variations during the test; the CO_2 concentration (dry basis) increased by about 60% (from 8% to 13%) while the oxygen concentration remained nearly constant. The gas analysis data sheets from the test are contained in the test file.

Coal and Dust Handling

The raw BNI lignite was prescreened before shipment to Colstrip; greatly reducing the potential for handling problems and none where realized.

The process dust from the BNI lignite did not present any unusual handling problems. While measuring the individual fines streams an exceptional volatility of the second stage dust was noted. The second stage dust showed spontaneous combustion within one hour after exposure air. This very quick spontaneous combustion has been noted when feeding Rosebud feedstock and is due mainly to the very high temperature of the second stage fines (450-500°F), but the BNI lignite second stage fines appeared to be even more volatile than Rosebud second stage fines.

Coal Upgrading Potential

Table 2 contains the summary coal analysis. Attachment 1 contains the coal analysis performed for the test including complete coal analysis of the main streams and analysis of the individual fines streams.

The product from this test was less dry than the product from the first BNI lignite test (7.4% vs 3.4%). The decrease in product dryness was probably caused by a combination of an decreased first stage dryer inlet temperature and a decreased gas flow rate to the second stage dryers. Both these differences were due to single vs. duel train operations and both these differences decreased the heat supply available to the coal in the dryers. On any additional tests the second stage gas inlet temperatures will be increased by about 30°F which will probably result in product moisture and heating values very similar to the previous test.

The product from the BNI lignite feedstock was upgraded 53% from the feed stock on a BTU/lb basis; and exhibited a 53% reduction in sulfur and a 35% reduction in ash on a lb/MMBTU basis. The fines produced during the test were upgraded 40% from the feed stock on a BTU/lb basis; and exhibited a 30% reduction in sulfur, but had a 3% increase in ash on a lb/MMBTU basis.

Table 2 - DEMO9336 Summary Coal Analysis of Composite Test Samples

Parameter	Raw Lignite Feed	Processed Lignite Product - Cleaned	Processed Lignite Product - Uncleaned	Cleaning System Waste	First Stage Dryer Product	Composite Process Fines
% Moisture	36.2	7.4	8.0	8.2	18.0	10.3
% Ash	6.5	6.5	8.4	13.5	6.1	9.5
% Sulfur	1.1	0.77	1.2	3.1	0.8	1.1
BTU/lb	7,064	10,799	10,475	9,841	9,270	9,914
MAF BTU/lb	12,331	12,538	12,537	12,558	12,202	12,354
Lb SO_2/MMBTU	3.0	1.4	2.3	6.2	1.8	2.1
Lb Ash/MMBTU	9.3	6.0	8.0	13.7	6.5	9.6
% VM	27.1	39.4	37.7	36.6	35.7	36.3
MAF % VM	47.4	45.7	45.1	46.7	47.0	45.3
% Fixed C	30.2	46.7	45.9	41.8	40.3	43.9
MAF % Fixed C	52.6	50.3	50.5	53.3	53.1	54.7
% Pyritic S	0.48	0.19	0.49	1.65	na	0.3
% Organic S	0.59	0.58	0.74	1.41	na	0.73
EQ % Moisture	35	20.1	19.4	19.3	na	21.9
Grindability (HGI)	32	43	47	47	na	48
Bulk Density	45.5	36.7	38	41.9	na	44.2

Washability Analysis

Float and sink washability analyses were performed on the processed BNI lignite product stream, waste stream and fines stream. As was true during the previous test (Demo 9326), the results continue to indicate good separation (cleaning) in the heavier fractions, especially below 1.5 specific gravity and especially around 1.8 specific gravity.[1] This test also confirmed the earlier results that the product could be near compliant containing 0.7% Sulfur and 11,500 btu/lb if separation at 1.4 specific gravity was achievable. What was not indicated from the earlier test was that there is an overwhelming amount of coal in the 1.30 to 1.40 specific gravity range. The product contained 82% within 1.40 +/-0.1 specific gravity range, while the waste contained 73% within this range, and the fines contained nearly 92% in this range. Standard methodology for cleaning of coal indicate that with such a large percentage within a very narrow specific gravity band, further cleaning will be very difficult.[2]

In summary, the air separation tables at the ACCP appear to do a fairly good job of separating the heavier size fractions and thus are able to remove a majority of the pyritic sulfur and some ash. Further cleaning of the coal is possible but may be quite difficult due to such a large percentage within 1.40 +/- 0.1 specific gravity.

Washability Analysis References:

1) BNI Test 9326 Test Report
2) Leonard, J.W., "Coal Preparation", American Institute of Mining, Metallurgical and Petroleum Engineers, Inc. 1979

SUMMARY

The process is very effective and efficient on BNI lignite. The process mass balance shifted slightly from the Rosebud feedstock, producing less product and, as expected, more vaporized water. No unusual handling problems were realized with either the BNI lignite raw feed or the process dust.

STANDARD LABORATORIES,INC.

2-NOV-93

SYNCOAL
LIGNITE

SAMPLE W176 BULK

JOB NO.:16303-931052- 1
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	36.17		34.98
ASH	6.54	10.25	6.66
VOLATILE	27.13	42.51	27.64
FIXED C	30.16	47.24	30.72
TOTAL	100.00	100.00	100.00
SULFUR	1.07	1.68	1.09
BTU/LB	7064	11067	7195
MAFBTU		12331	

EQUILIBRIUM MOISTURE (%)

34.98

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	36.17		34.98
ASH	6.54	10.25	6.66
SULFUR	1.07	1.68	1.09
NITROGEN	0.59	0.92	0.60
CARBON	42.25	66.19	43.03
HYDROGEN	2.62	4.11	2.67
OXYGEN	10.76	16.85	10.97
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.05
SILICON DIOXIDE	19.33
FERRIC OXIDE	14.88
ALUMINUM OXIDE	9.00
TITANIUM DIOXIDE	0.42
MANGANESE DIOXIDE	0.05
CALCIUM OXIDE	18.40
MAGNESIUM OXIDE	5.35
POTASSIUM OXIDE	0.65
SODIUM OXIDE	2.76
SULFUR TRIOXIDE	23.50
BARIUM OXIDE	0.38
STRONTIUM OXIDE	0.50
UNDETERMINED	4.73
TOTAL	100.00

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	<0.01	<0.01
PYRITIC	0.48	0.76
ORGANIC	0.59	0.92
TOTAL	1.07	1.68

FUSION TEMPERATURE OF ASH (F)

	OXIDIZING	REDUCING
INITIAL	2256	2245
SOFTENING	2294	2285
HEMISPHERICAL	2301	2298
FLUID	2316	2312

ADDITIONAL DATA

LBS H2O/MM BTU	51.20
LBS ASH/MM BTU	9.26
LBS SULFUR/MM BTU	1.51
BASE/ACID RATIO	1.46
T250	2001 DEG F
SILICA RATIO	33.35
SLAGGING TYPE	HIGH
FOULING TYPE	SEVERE
% ALKALI AS NA2O	0.33
CR VISC <10 POISE AT 2485 F	
BULK DENSITY	45.5 lbs/cu. ft.

GRINDABILITY (HGI)

H G I 32
AT 25.59% MOISTURE

WATER SOLUBLE ALKALIES (%)

	AS RECD	DRY
SODIUM OXIDE	0.132	0.207
POTASSIUM OXIDE	0.005	0.008

SYNCOAL
LIGNITE

SAMPLE W176 GRAB

JOB NO.:16303-931052- 3
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	36.97	
ASH	6.73	10.68
VOLATILE	26.82	42.55
FIXED C	29.48	46.77
	------	------
TOTAL	100.00	100.00
SULFUR	0.98	1.56
BTU/LB	6913	10968
MAFBTU		12279

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	36.97	
ASH	6.73	10.68
SULFUR	0.98	1.56
NITROGEN	0.57	0.90
CARBON	41.64	66.07
HYDROGEN	2.58	4.10
OXYGEN	10.53	16.69
	------	------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	0.01	0.02
PYRITIC	0.40	0.64
ORGANIC	0.57	0.90
	------	------
TOTAL	0.98	1.56

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	53.48
LBS ASH/MM BTU	9.73
LBS SULFUR/MM BTU	1.42

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
SAMPLE W-1-76

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 102.00 POUNDS

		WEIGHT LBS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	: RETAINED ON 1 IN. RD.	36.60	35.89	64.11	35.89
PASSING 1 IN. RD.	: RETAINED ON 1/2 IN. RD.	51.20	50.21	13.90	86.10
PASSING 1/2 IN. RD.	: RETAINED ON 1/4 IN. RD.	8.10	7.94	5.96	94.04
PASSING 1/4 IN. RD.	: RETAINED ON NO.4	0.20	0.20	5.77	94.23
PASSING NO.4	: RETAINED ON NO.8	2.02	1.98	3.79	96.21
PASSING NO.8	: RETAINED ON NO.16	1.23	1.21	2.58	97.42
PASSING NO.16	: RETAINED ON NO.30	0.79	0.77	1.80	98.20
PASSING NO.30	: RETAINED ON NO.50	0.64	0.63	1.18	98.82
PASSING NO.50	: RETAINED ON PAN	1.20	1.18	0.00	100.00

TOTAL RECOVERED WEIGHT: 101.98
PER CENT RECOVERY: 99.98

931052-1

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT

SAMPLE R41

JOB NO.:6303-931056- 6
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	18.60	
ASH	5.88	7.22
VOLATILE	35.53	43.65
FIXED C	39.99	49.13
TOTAL	100.00	100.00
SULFUR	0.74	0.91
BTU/LB	9228	11337
MAFBTU		12219

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	18.60	
ASH	5.88	7.22
SULFUR	0.74	0.91
NITROGEN	0.79	0.97
CARBON	54.40	66.83
HYDROGEN	3.61	4.44
OXYGEN	15.98	19.63
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H20/MM BTU	20.15
LBS ASH/MM BTU	6.37
LBS SULFUR/MM BTU	0.80

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

:YNCOAL
IGNITE PROJECT

AMPLE R42

JOB NO.:6303-931056- 7
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	17.34	
ASH	6.24	7.55
VOLATILE	35.90	43.43
FIXED C	40.52	49.02
TOTAL	100.00	100.00
SULFUR	0.88	1.06
BTU/LB	9311	11265
MAFBTU		12185

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	17.34	
ASH	6.24	7.55
SULFUR	0.88	1.06
NITROGEN	0.83	1.01
CARBON	55.13	66.69
HYDROGEN	3.57	4.32
OXYGEN	16.01	19.37
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H20/MM BTU	18.62
LBS ASH/MM BTU	6.70
LBS SULFUR/MM BTU	0.95

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

2-NOV-93

SYNCOAL
LIGNITE

SAMPLE C506 BULK

JOB NO.:6303-931052- 2
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	8.03		19.40
ASH	8.41	9.15	7.37
VOLATILE	37.66	40.95	33.00
FIXED C	45.90	49.90	40.23
TOTAL	100.00	100.00	100.00
SULFUR	1.23	1.34	1.08
BTU/LB	10475	11390	9180
MAFBTU		12537	

EQUILIBRIUM MOISTURE (%)
19.40

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	8.03		19.40
ASH	8.41	9.15	7.37
SULFUR	1.23	1.34	1.08
NITROGEN	0.84	0.91	0.73
CARBON	62.12	67.54	54.43
HYDROGEN	3.93	4.27	3.44
OXYGEN	15.44	16.79	13.55
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.02
SILICON DIOXIDE	19.22
FERRIC OXIDE	12.42
ALUMINUM OXIDE	9.20
TITANIUM DIOXIDE	0.47
MANGANESE DIOXIDE	0.06
CALCIUM OXIDE	20.71
MAGNESIUM OXIDE	5.86
POTASSIUM OXIDE	0.61
SODIUM OXIDE	3.26
SULFUR TRIOXIDE	22.80
BARIUM OXIDE	0.30
STRONTIUM OXIDE	0.54
UNDETERMINED	4.53
TOTAL	100.00

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	<0.01	<0.01
PYRITIC	0.49	0.53
ORGANIC	0.74	0.81
TOTAL	1.23	1.34

FUSION TEMPERATURE OF ASH (F)

	OXIDIZING	REDUCING
INITIAL	2314	2296
SOFTENING	2329	2327
HEMISPHERICAL	2339	2338
FLUID	2354	2353

ADDITIONAL DATA

LBS H2O/MM BTU	7.67
LBS ASH/MM BTU	8.03
LBS SULFUR/MM BTU	1.17
BASE/ACID RATIO	1.48
T250	1902 DEG F
SILICA RATIO	33.02
SLAGGING TYPE	MEDIUM
FOULING TYPE	SEVERE
% ALKALI AS NA2O	0.34
CR VISC <10 POISE AT 2527 F	
BULK DENSITY	38.0 lbs/cu. ft.

GRINDABILITY (HGI)
H G I 47
AT 6.08% MOISTURE

WATER SOLUBLE ALKALIES (%)

	AS RECD	DRY
SODIUM OXIDE	0.234	0.254
POTASSIUM OXIDE	0.009	0.010

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
SAMPLE C-5-06

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 74.80 POUNDS

			WEIGHT LBS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	;	RETAINED ON 1 IN. RD.	0.30	0.40	99.60	0.40
PASSING 1 IN. RD.	;	RETAINED ON 1/2 IN. RD.	4.10	5.50	94.10	5.90
PASSING 1/2 IN. RD.	;	RETAINED ON 1/4 IN. RD.	9.80	13.14	80.96	19.04
PASSING 1/4 IN. RD.	;	RETAINED ON NO.4	1.00	1.34	79.62	20.38
PASSING NO.4	;	RETAINED ON NO.8	14.83	19.88	59.74	40.26
PASSING NO.8	;	RETAINED ON NO.16	25.00	33.52	26.22	73.78
PASSING NO.16	;	RETAINED ON NO.30	15.59	20.90	5.32	94.68
PASSING NO.30	;	RETAINED ON NO.50	3.44	4.61	0.71	99.29
PASSING NO.50	;	RETAINED ON PAN	0.53	0.71	0.00	100.00

TOTAL RECOVERED WEIGHT: 74.59
PER CENT RECOVERY: 99.72

9310552-2

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
IGNITE PROJECT
JLK SAMPLE
AMPLE C908

JOB NO.:6303-931053- 1
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	7.35		20.12
ASH	6.52	7.04	5.62
VOLATILE	39.39	42.51	33.96
FIXED C	46.74	50.45	40.30
	------	------	------
TOTAL	100.00	100.00	100.00
SULFUR	0.77	0.83	0.66
BTU/LB	10799	11655	9310
MAFBTU		12538	

EQUILIBRIUM MOISTURE (%)

20.12

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	7.35		20.12
ASH	6.52	7.04	5.62
SULFUR	0.77	0.83	0.66
NITROGEN	0.88	0.95	0.76
CARBON	64.15	69.24	55.31
HYDROGEN	4.11	4.44	3.55
OXYGEN	16.22	17.50	13.98
	------	------	------
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.09
SILICON DIOXIDE	14.99
FERRIC OXIDE	7.91
ALUMINUM OXIDE	9.97
TITANIUM DIOXIDE	0.44
MANGANESE DIOXIDE	0.07
CALCIUM OXIDE	27.72
MAGNESIUM OXIDE	7.54
POTASSIUM OXIDE	0.50
SODIUM OXIDE	3.70
SULFUR TRIOXIDE	22.00
BARIUM OXIDE	0.36
STRONTIUM OXIDE	0.69
UNDETERMINED	4.02

TOTAL	100.00

FORMS OF SULFUR (%)

	AS RECD	DRY
ULFATE	<0.01	<0.01
YRITIC	0.19	0.21
RGANIC	0.58	0.62
	------	------
OTAL	0.77	0.83

FUSION TEMPERATURE OF ASH (F)

	OXIDIZING	REDUCING
INITIAL	2395	2368
SOFTENING	2399	2390
HEMISPHERICAL	2403	2397
FLUID	2408	2405

ADDITIONAL DATA

LBS H2O/MM BTU	6.31
LBS ASH/MM BTU	6.04
LBS SULFUR/MM BTU	0.71
BASE/ACID RATIO	1.86
T250	2460 DEG F
SILICA RATIO	25.77
SLAGGING TYPE	MEDIUM
FOULING TYPE	SEVERE
% ALKALI AS NA2O	0.28
BULK DENSITY	36.7 lbs/cu f

GRINDABILITY (HGI)

G I 43
T 6.05% MOISTURE

WATER SOLUBLE ALKALIES (%)

	AS RECD	DRY
SODIUM OXIDE	0.150	0.162
POTASSIUM OXIDE	0.005	0.005

... its best efforts, in accordance with the standards and

STANDARD LABORATORIES, INC.

20-OCT-93

YNCOAL
GNITE PROJECT
:AB SAMPLE
MPLE C908

JOB NO.:6303-931053- 2
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
OISTURE	7.28	
ASH	6.55	7.06
OLATILE	38.68	41.72
FIXED C	47.49	51.22
TOTAL	100.00	100.00
SULFUR	0.72	0.78
TU/LB	10809	11658
AFBTU		12544

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	7.28	
ASH	6.55	7.06
SULFUR	0.72	0.78
NITROGEN	0.89	0.96
CARBON	63.68	68.68
HYDROGEN	4.13	4.45
OXYGEN	16.75	18.07
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
LFATE	<0.01	<0.01
RITIC	0.18	0.19
GANIC	0.54	0.59
TAL	0.72	0.78

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	6.73
LBS ASH/MM BTU	6.06
LBS SULFUR/MM BTU	0.67

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
SAMPLE C-9-08

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 44.60 POUNDS

		WEIGHT LBS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	; RETAINED ON 1 IN. RD.	0.00	0.00	100.00	0.00
PASSING 1 IN. RD.	; RETAINED ON 1/2 IN. RD.	0.40	0.90	99.10	0.90
PASSING 1/2 IN. RD.	; RETAINED ON 1/4 IN. RD.	3.30	7.40	91.70	8.30
PASSING 1/4 IN. RD.	; RETAINED ON NO.4	0.80	1.79	89.90	10.10
PASSING NO.4	; RETAINED ON NO.8	16.47	36.95	52.95	47.05
PASSING NO.8	; RETAINED ON NO.16	13.24	29.71	23.24	76.76
PASSING NO.16	; RETAINED ON NO.30	8.11	18.20	5.05	94.95
PASSING NO.30	; RETAINED ON NO.50	1.99	4.46	0.58	99.42
PASSING NO.50	; RETAINED ON PAN	0.26	0.58	0.00	100.00

TOTAL RECOVERED WEIGHT: 44.57
PER CENT RECOVERY: 99.93

STANDARD LABORATORIES, INC.

JOB #	AIR DRY LOSS	RESDL MOIST	AS RECVD MOIST	AS RECVD ASH	DRY ASH	AS RECVD VM	DRY VM	AS RECVD FC	DRY FC	AS RECVD SULF	DRY SULF	AS RECVD BTU	DRY BTU	MAF BTU
931053 1	1.80	5.65	7.35	6.52	7.04	0.00	0.00	0.00	0.00	0.77	0.83	10799	11655	12538
SAMPLE C908 BULK SAMPLE														
931053 2	2.15	5.24	7.28	6.55	7.06	0.00	0.00	0.00	0.00	0.72	0.78	10809	11658	12544
SAMPLE C908 GRAB SAMPLE														
931053 3	0.00	8.35	8.35	6.42	7.00	0.00	0.00	0.00	0.00	0.80	0.87	10770	11751	12636
SAMPLE C908 BULK SIEVE TOP X 1/2														
931053 4	0.00	6.25	6.25	5.96	6.36	0.00	0.00	0.00	0.00	0.68	0.73	11168	11913	12722
1/2 X 1/4														
931053 5	0.00	6.06	6.06	5.70	6.07	0.00	0.00	0.00	0.00	0.64	0.68	11127	11844	12610
1/4 X 4 MESH														
931053 6	0.00	6.65	6.65	6.84	7.33	0.00	0.00	0.00	0.00	0.70	0.75	10867	11641	12562
4 MESH X 8 MESH														
931053 7	0.00	8.14	8.14	6.89	7.50	0.00	0.00	0.00	0.00	0.73	0.79	10581	11518	12452
-8 MESH														

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
IGNITE PROJECT
OF X 1/2
AMPLE C908 BULK SIEVE

JOB NO.:6303-931053- 3
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%) | ULTIMATE ANALYSIS (%) | MINERAL ANALYSIS OF ASH (%)

	AS RECD	DRY
MOISTURE	8.35	
ASH	6.42	7.00
VOLATILE	40.94	44.67
FIXED C	44.29	48.33
TOTAL	100.00	100.00
SULFUR	0.80	0.87
BTU/LB	10770	11751
MAFBTU		12636

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%) | FUSION TEMPERATURE OF ASH (F) | ADDITIONAL DATA

LBS H2O/MM BTU	7.75
LBS ASH/MM BTU	5.96
LBS SULFUR/MM BTU	0.74

GRINDABILITY (HGI) | WATER SOLUBLE ALKALIES (%)

SL does not guarantee any results of its services but has agreed to use its best efforts, in accordance with the standards and

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
IGNITE PROJECT

/2 X 1/4

JOB NO.:6303-931053- 4
LOCATION:CASPER, WY
CHEMIST: KRA

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	6.25	
ASH	5.96	6.36
VOLATILE	40.56	43.26
FIXED C	47.23	50.38
	------	------
TOTAL	100.00	100.00
SULFUR	0.68	0.73
BTU/LB	11168	11913
MAFBTU		12722

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	5.60
LBS ASH/MM BTU	5.34
LBS SULFUR/MM BTU	0.61

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
IGNITE PROJECT

/4 X 4 MESH

JOB NO.:6703-931053- 5
LOCATION:CASPER, WY
CHEMIST: SRM

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	6.06	
ASH	5.70	6.07
VOLATILE	39.73	42.29
FIXED C	48.51	51.64
TOTAL	100.00	100.00
SULFUR	0.64	0.68
BTU/LB	11127	11844
MAFBTU		12610

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	5.45
LBS ASH/MM BTU	5.12
LBS SULFUR/MM BTU	0.58

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SL does not guarantee any results of its services but has agreed to use its best efforts, in accordance with the standards and

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT

1 MESH X 8 MESH

JOB NO.:6303-931053- 6
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	6.65	
ASH	6.84	7.33
VOLATILE	39.02	41.80
FIXED C	47.49	50.87
TOTAL	100.00	100.00
SULFUR	0.70	0.75
BTU/LB	10867	11641
MAFBTU		12562

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H20/MM BTU	6.12
LBS ASH/MM BTU	6.29
LBS SULFUR/MM BTU	0.64

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES,INC.

20-OCT-93

;YNCOAL
IGNITE PROJECT

8 MESH

JOB NO.:6403-931053- 7
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.14	
ASH	6.89	7.50
VOLATILE	44.18	48.10
FIXED C	40.79	44.40
TOTAL	100.00	100.00
SULFUR	0.73	0.79
BTU/LB	10581	11518
MAFBTU		12452

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	7.69
LBS ASH/MM BTU	6.51
LBS SULFUR/MM BTU	0.69

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SL does not guarantee an... results of its services but has agreed to use its best efforts, in accordance with the standards and

FLOAT AND SINK ANALYSIS

DRY BASIS

SAMPLE SOURCE : SAMPLE C908 BULK WASH — SYNCOAL
FRACTION SIZE : TOP X 0 — 6303-931053
INITIAL WT. : 12212.60 GRAMS — 20-OCT-93

			FRACTION ANALYSIS DRY BASIS				CUMULATIVE RECOVERY FLOAT				CUMULATIVE REJECT SINK			
S#	SPECIFIC GRAVITY	*WT.	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU
8	FLOAT-1.30	1910.10	15.7	4.32	0.57	12086	15.7	4.32	0.57	12086	100.0	7.04	0.84	11541
9	1.30-1.40	9015.10	74.1	6.12	0.69	11654	89.8	5.81	0.67	11730	84.3	7.54	0.89	11440
10	1.40-1.50	991.40	8.2	11.09	1.08	10805	98.0	6.24	0.70	11653	10.2	17.92	2.33	9876
11	1.50-1.60	79.80	0.7	23.33	3.42	9238	98.6	6.36	0.72	11637	2.0	45.42	7.36	6133
12	1.60-1.80	61.90	0.5	36.71	4.81	7328	99.1	6.51	0.74	11615	1.4	56.03	9.25	4642
13	1.80-SINK	104.30	0.9	67.50	11.88	3048	100.0	7.04	0.84	11541	0.9	67.50	11.88	3048

RECOVERED WT: 12162.60 GRAMS

*--WEIGHT IN GRAMS

STANDARD LABORATORIES,INC.

20-OCT-93

YNCOAL
AMPLE C908 BULK WASH
LOAT-1.30
OF X 0

JOB NO.:6303-931053- 8
LOCATION:CASPER, WY
CHEMIST: MM

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	6.29	
ASH	4.05	4.32
VOLATILE	41.24	44.01
FIXED C	48.42	51.67
	------	------
TOTAL	100.00	100.00
SULFUR	0.53	0.57
BTU/LB	11326	12086
MAFBTU		12632

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	5.55
LBS ASH/MM BTU	3.58
LBS SULFUR/MM BTU	0.47

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE C908 BULK WASH
1.30-1.40

JOB NO.:6303-931053- 9
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.91	
ASH	5.51	6.12
VOLATILE	37.98	42.16
FIXED C	46.60	51.72
	------	------
TOTAL	100.00	100.00
SULFUR	0.62	0.69
BTU/LB	10499	11654
MAFBTU		12414

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.44
LBS ASH/MM BTU	5.25
LBS SULFUR/MM BTU	0.59

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
AMPLE C908 BULK WASH
.40-1.50

JOB NO.:6303-931053- 10
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.36	
ASH	10.05	11.09
VOLATILE	34.99	38.60
FIXED C	45.60	50.31
TOTAL	100.00	100.00
SULFUR	0.98	1.08
BTU/LB	9793	10805
MAFBTU		12152

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.56
LBS ASH/MM BTU	10.26
LBS SULFUR/MM BTU	1.00

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE C908 BULK WASH
.50-1.60

JOB NO.:6303-931053- 11
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.28	
ASH	21.40	23.33
VOLATILE	31.30	34.13
FIXED C	39.02	42.54
	------	------
TOTAL	100.00	100.00
SULFUR	3.14	3.42
BTU/LB	8473	9238
MAFBTU		12050

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.77
LBS ASH/MM BTU	25.25
LBS SULFUR/MM BTU	3.71

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
AMPLE C908 BULK WASH
.60-1.80

JOB NO.:6303-931053- 12
LOCATION:CASPER, WY
CHEMIST: HCM

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	13.53	
ASH	31.74	36.71
VOLATILE	25.57	29.57
FIXED C	29.16	33.72
TOTAL	100.00	100.00
SULFUR	4.16	4.81
BTU/LB	6337	7328
MAFBTU		11579

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	21.35
LBS ASH/MM BTU	50.08
LBS SULFUR/MM BTU	6.56

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

;YNCOAL
AMPLE C908 BULK WASH
.80-SINK

JOB NO.:6303-931053- 13
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	10.75	
ASH	60.24	67.50
VOLATILE	17.75	19.89
FIXED C	11.26	12.61
	------	------
TOTAL	100.00	100.00
SULFUR	10.60	11.88
BTU/LB	2721	3048
MAFBTU		9380

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU 39.51

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
IGNITE PROJECT
ULK SAMPLE
AMPLE C809

JOB NO.:6303-931054- 1
LOCATION:CASPER, WY
CHEMIST: KM

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	8.15		19.28
ASH	13.48	14.68	11.85
VOLATILE	36.61	39.86	32.18
FIXED C	41.76	45.46	36.69
TOTAL	100.00	100.00	100.00
SULFUR	3.06	3.33	2.69
BTU/LB	9841	10714	8649
MAFBTU		12558	

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	8.15		19.28
ASH	13.48	14.68	11.85
SULFUR	3.06	3.33	2.69
NITROGEN	0.85	0.93	0.75
CARBON	57.58	62.69	50.61
HYDROGEN	3.66	3.98	3.21
OXYGEN	13.22	14.39	11.61
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.05
SILICON DIOXIDE	22.16
FERRIC OXIDE	21.78
ALUMINUM OXIDE	8.31
TITANIUM DIOXIDE	0.35
MANGANESE DIOXIDE	0.04
CALCIUM OXIDE	13.35
MAGNESIUM OXIDE	3.92
POTASSIUM OXIDE	0.89
SODIUM OXIDE	2.34
SULFUR TRIOXIDE	19.70
BARIUM OXIDE	0.21
STRONTIUM OXIDE	0.35
UNDETERMINED	6.55
TOTAL	100.00

EQUILIBRIUM MOISTURE (%)

19.28

FORMS OF SULFUR (%)

	AS RECD	DRY
ULFATE	<0.01	<0.01
YRITIC	1.65	1.80
RGANIC	1.41	1.53
OTAL	3.06	3.33

FUSION TEMPERATURE OF ASH (F)

	OXIDIZING	REDUCING
INITIAL	2169	2064
SOFTENING	2218	2074
HEMISPHERICAL	2235	2082
FLUID	2310	2114

ADDITIONAL DATA

LBS H2O/MM BTU	8.28
LBS ASH/MM BTU	13.70
LBS SULFUR/MM BTU	3.11
BASE/ACID RATIO	1.37
T250	2365 DEG F
SILICA RATIO	36.20
SLAGGING TYPE	SEVERE
FOULING TYPE	SEVERE
% ALKALI AS NA2O	0.43
CR VISC <10 POISE AT	2274 F
BULK DENSITY	41.9 lbs/cu. ft

GRINDABILITY (HGI)

G I 47
T 6.26% MOISTURE

WATER SOLUBLE ALKALIES (%)

	AS RECD	DRY
SODIUM OXIDE	0.186	0.203
POTASSIUM OXIDE	0.008	0.009

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT
GRAB SAMPLE
SAMPLE C809

JOB NO.:6403-931054- 2
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	7.03	
ASH	13.13	14.12
VOLATILE	36.79	39.57
FIXED C	43.05	46.31
TOTAL	100.00	100.00
SULFUR	2.94	3.16
BTU/LB	10041	10801
MAFBTU		12577

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	7.03	
ASH	13.13	14.12
SULFUR	2.94	3.16
NITROGEN	0.80	0.86
CARBON	58.44	62.86
HYDROGEN	3.77	4.06
OXYGEN	13.89	14.94
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	0.01	0.01
PYRITIC	1.56	1.68
ORGANIC	1.37	1.47
TOTAL	2.94	3.16

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	7.00
LBS ASH/MM BTU	13.08
LBS SULFUR/MM BTU	2.93

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SL does not guarantee any results of its services but has agreed to use its best efforts, in accordance with the standards and

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
SAMPLE C-8-09

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 53.90 POUNDS

		WEIGHT LBS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	: RETAINED ON 1 IN. RD.	0.70	1.30	98.70	1.30
PASSING 1 IN. RD.	: RETAINED ON 1/2 IN. RD.	5.30	9.86	88.84	11.16
PASSING 1/2 IN. RD.	: RETAINED ON 1/4 IN. RD.	5.87	10.92	77.92	22.08
PASSING 1/4 IN. RD.	: RETAINED ON NO.4	0.63	1.17	76.74	23.26
PASSING NO.4	: RETAINED ON NO.8	3.55	6.60	70.14	29.86
PASSING NO.8	: RETAINED ON NO.16	25.41	47.27	22.87	77.13
PASSING NO.16	: RETAINED ON NO.30	11.17	20.78	2.08	97.92
PASSING NO.30	: RETAINED ON NO.50	1.11	2.07	0.02	99.98
PASSING NO.50	: RETAINED ON PAN	0.01	0.02	0.00	100.00

TOTAL RECOVERED WEIGHT: 53.75
PER CENT RECOVERY: 99.72

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT
TOP X 1/2
SAMPLE C809 BULK SIEVE

JOB NO.:6303-931054- 3
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	6.37	
ASH	34.21	36.54
VOLATILE	28.26	30.18
FIXED C	31.16	33.28
TOTAL	100.00	100.00
SULFUR	13.00	13.88
BTU/LB	6998	7474
MAFBTU		11777

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.10
LBS ASH/MM BTU	48.88
LBS SULFUR/MM BTU	18.58

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT

1/2 X 1/4

JOB NO.:16303-931054- 4
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	5.92	
ASH	23.49	24.97
VOLATILE	37.21	39.55
FIXED C	33.38	35.48
	------	------
TOTAL	100.00	100.00
SULFUR	6.06	6.44
BTU/LB	8768	9320
MAFBTU		12422

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	6.75
LBS ASH/MM BTU	26.79
LBS SULFUR/MM BTU	6.91

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT

1/4 X 4 MESH

JOB NO.:6303-931054- 5
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	5.59	
ASH	18.92	20.04
VOLATILE	34.51	36.55
FIXED C	40.98	43.41
	------	------
TOTAL	100.00	100.00
SULFUR	4.55	4.82
BTU/LB	9480	10041
MAFBTU		12559

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	5.90
LBS ASH/MM BTU	19.96
LBS SULFUR/MM BTU	4.80

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LA[illegible]

20-OCT-93

SYNCOAL
LIGNITE PROJECT

4 MESH X 8 MESH

JOB NO.:6303-931054- 6
LOCATION:CASPER, WY
CHEMIST: KM

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	6.06	
ASH	18.79	20.00
VOLATILE	34.43	36.65
FIXED C	40.72	43.35
	------	------
TOTAL	100.00	100.00
SULFUR	2.30	2.45
BTU/LB	9398	10004
MAFBTU		12505

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	6.45
LBS ASH/MM BTU	19.99
LBS SULFUR/MM BTU	2.45

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT

-8 MESH

JOB NO.:6303-931054- ?
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.65	
ASH	7.74	8.47
VOLATILE	38.21	41.83
FIXED C	45.40	49.70
TOTAL	100.00	100.00
SULFUR	0.83	0.91
BTU/LB	10370	11352
MAFBTU		12402

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	8.34
LBS ASH/MM BTU	7.46
LBS SULFUR/MM BTU	0.80

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

FLOAT AND SINK ANALYSIS

DRY BASIS

SAMPLE SOURCE : SAMPLE C809 BULK WASH
FRACTION SIZE : TOP X 0
INITIAL WT. : 13983.20 GRAMS

SYNCOAL
6303-931054
20-OCT-93

			FRACTION ANALYSIS DRY BASIS					CUMULATIVE RECOVERY FLOAT				CUMULATIVE REJECT SINK			
S#	SPECIFIC GRAVITY	*WT.	%WT	%ASH	%S	BTU		%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU
8	FLOAT-1.30	1739.10	12.4	5.04	0.58	11930		12.4	5.04	0.58	11930	100.0	15.39	4.68	10327
9	1.30-1.40	8413.00	60.2	6.62	0.68	11569		72.6	6.35	0.66	11630	87.6	16.86	5.27	10099
10	1.40-1.50	1738.70	12.4	10.61	1.05	10892		85.0	6.97	0.72	11522	27.4	39.34	15.34	6872
11	1.50-1.60	153.10	1.1	23.96	3.95	9186		86.1	7.19	0.76	11493	15.0	63.22	27.21	3531
12	1.60-1.80	98.90	0.7	39.09	5.77	7072		86.8	7.45	0.80	11457	13.9	66.32	29.05	3085
13	1.80-SINK	1840.40	13.2	67.78	30.30	2870		100.0	15.39	4.68	10327	13.2	67.78	30.30	2870

RECOVERED WT: 13983.20 GRAMS

*--WEIGHT IN GRAMS

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE C809 BULK WASH
FLOAT-1.30
TOP X 0

JOB NO.16303-931054- 8
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	7.59	
ASH	4.66	5.04
VOLATILE	40.75	44.10
FIXED C	47.00	50.86
TOTAL	100.00	100.00
SULFUR	0.54	0.58
BTU/LB	11025	11930
MAFBTU		12563

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	6.88
LBS ASH/MM BTU	4.23
LBS SULFUR/MM BTU	0.49

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

20-OCT-93

SYNCOAL
SAMPLE CB09 BULK WASH
1.30-1.40

JOB NO.:6303-931054- 9
LOCATION:CASPER, WY
CHEMIST: MAL

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	10.22	
ASH	5.94	6.62
VOLATILE	38.40	42.77
FIXED C	45.44	50.61
TOTAL	100.00	100.00
SULFUR	0.61	0.68
BTU/LB	10386	11569
MAFBTU		12389

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.84
LBS ASH/MM BTU	5.72
LBS SULFUR/MM BTU	0.59

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE C809 BULK WASH
1.40-1.50

JOB NO.:16303-931054- 10
LOCATION:CASPER, WY
CHEMIST: RMJ

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	10.05	
ASH	9.54	10.61
VOLATILE	36.09	40.12
FIXED C	44.32	49.27
TOTAL	100.00	100.00
SULFUR	0.94	1.05
BTU/LB	9797	10892
MAFBTU		12185

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	10.26
LBS ASH/MM BTU	9.74
LBS SULFUR/MM BTU	0.96

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE C809 BULK WASH
1.50-1.60

JOB NO.:6303-931054- 11
LOCATION:CASPER, WY
CHEMIST: JW

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.42	
ASH	21.94	23.96
VOLATILE	31.21	34.08
FIXED C	38.43	41.96
TOTAL	100.00	100.00
SULFUR	3.62	3.95
BTU/LB	8413	9186
MAFBTU		12081

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	10.01
LBS ASH/MM BTU	26.08
LBS SULFUR/MM BTU	4.30

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE C809 BULK WASH
1.60-1.80

JOB NO.:6303-931054- 12
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	14.38	
ASH	33.47	39.09
VOLATILE	24.45	28.56
FIXED C	27.70	32.35
TOTAL	100.00	100.00
SULFUR	4.94	5.77
BTU/LB	6055	7072
MAFBTU		11611

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	23.75
LBS ASH/MM BTU	55.27
LBS SULFUR/MM BTU	8.16

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
SAMPLE CB09 BULK WASH
1.80-SINK

JOB NO.:6303-931054- 13
LOCATION:CASPER, WY
CHEMIST: MM

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	4.95	
ASH	64.42	67.78
VOLATILE	17.75	18.68
FIXED C	12.88	13.54
	------	------
TOTAL	100.00	100.00
SULFUR	28.80	30.30
BTU/LB	2728	2870
MAFBTU		8910

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	18.14
LBS ASH/MM BTU	236.08
LBS SULFUR/MM BTU	105.54

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

931054

JOB #	AIR DRY LOSS	RESDL MOIST	AS RECVD MOIST	AS RECVD ASH	DRY ASH	AS RECVD VM	DRY VM	AS RECVD FC	DRY FC	AS RECVD SULF	DRY SULF	AS RECVD BTU	DRY BTU	MAF BTU
931054 1	2.54	5.76	8.15	13.48	14.68	36.61	39.86	41.76	45.46	3.06	3.33	9841	10714	12558
SAMPLE C809 BULK SAMPLE														
931054 2	2.15	4.99	7.03	13.13	14.12	36.79	39.57	43.05	46.31	2.94	3.16	10041	10801	12577
SAMPLE C809 GRAB SAMPLE														
931054 3	0.00	6.37	6.37	34.21	36.54	28.26	30.18	31.16	33.28	13.00	13.88	6998	7474	11777
SAMPLE C809 BULK SIEVE TOP X 1/2														
931054 4	0.00	5.92	5.92	23.49	24.97	37.21	39.55	33.38	35.48	6.06	6.44	8768	9320	12422
1/2 X 1/4														
931054 5	0.00	5.59	5.59	18.92	20.04	34.51	36.55	40.98	43.41	4.55	4.82	9480	10041	12558
1/4 X 4 MESH														
931054 6	0.00	6.06	6.06	18.79	20.00	34.43	36.65	40.72	43.35	2.30	2.45	9398	10004	12505
4 MESH X 8 MESH														
931054 7	0.00	8.65	8.65	7.74	8.47	38.21	41.83	45.40	49.70	0.83	0.91	10370	11352	12402
-8 MESH														
931054 8	0.00	7.59	7.59	4.66	5.04	40.75	44.10	47.00	50.86	0.54	0.58	11025	11930	12563
TOP X 0 FLOAT-1.30														
931054 9	0.00	10.22	10.22	5.94	6.62	38.40	42.77	45.44	50.61	0.61	0.68	10386	11569	12389
1.30-1.40														
931054 10	0.00	10.05	10.05	9.54	10.61	36.09	40.12	44.32	49.27	0.94	1.05	9797	10892	12185
1.40-1.50														
931054 11	0.00	8.42	8.42	21.94	23.96	31.21	34.08	38.43	41.96	3.62	3.95	8413	9186	12081
1.50-1.60														
931054 12	0.00	14.38	14.38	33.47	39.09	24.45	28.56	27.70	32.35	4.94	5.77	6055	7072	11611
1.60-1.80														

STANDARD LABORATORIES, INC.

931054

JOB #	AIR DRY LOSS	RESDL MOIST	AS RECVD MOIST	AS RECVD ASH	DRY ASH	AS RECVD VM	DRY VM	AS RECVD FC	DRY FC	AS RECVD SULF	DRY SULF	AS RECVD BTU	DRY BTU	MAF BTU
931054 13	0.00	4.95	4.95	64.42	67.78	17.75	18.68	12.88	13.54	28.80	30.30	2728	2870	8910
1.80-SINK														

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT
BULK SAMPLE
SAMPLE T090

JOB NO.:6303-931055- 1
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	10.26		21.92
ASH	9.49	10.57	8.25
VOLATILE	36.33	40.48	31.61
FIXED C	43.92	48.95	38.22
TOTAL	100.00	100.00	100.00
SULFUR	1.06	1.18	0.92
BTU/LB	9914	11048	8626
MAFBTU		12354	

EQUILIBRIUM MOISTURE (%)

21.92

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	10.26		21.92
ASH	9.49	10.57	8.25
SULFUR	1.06	1.18	0.92
NITROGEN	0.93	1.04	0.81
CARBON	59.17	65.94	51.49
HYDROGEN	3.74	4.17	3.26
OXYGEN	15.35	17.10	13.35
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.09
SILICON DIOXIDE	25.86
FERRIC OXIDE	8.68
ALUMINUM OXIDE	10.66
TITANIUM DIOXIDE	0.55
MANGANESE DIOXIDE	0.07
CALCIUM OXIDE	21.20
MAGNESIUM OXIDE	5.33
POTASSIUM OXIDE	0.72
SODIUM OXIDE	2.98
SULFUR TRIOXIDE	18.20
BARIUM OXIDE	0.59
STRONTIUM OXIDE	0.54
UNDETERMINED	4.01
TOTAL	100.00

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	0.03	0.03
PYRITIC	0.30	0.34
ORGANIC	0.73	0.81
TOTAL	1.06	1.18

FUSION TEMPERATURE OF ASH (F)

	OXIDIZING	REDUCING
INITIAL	2260	2236
SOFTENING	2268	2267
HEMISPHERICAL	2274	2273
FLUID	2306	2290

ADDITIONAL DATA

LBS H2O/MM BTU		10.35
LBS ASH/MM BTU		9.57
LBS SULFUR/MM BTU		1.07
BASE/ACID RATIO		1.06
T250	2227	DEG F
SILICA RATIO		42.00
SLAGGING TYPE		MEDIUM
FOULING TYPE		SEVERE
% ALKALI AS NA2O		0.5[illegible]
CR VISC <10 POISE AT 2467 F		

BULK DENSITY 44.2 lbs/cu. ft.

GRINDABILITY (HGI)

HGI 48
AT 7.16% MOISTURE

WATER SOLUBLE ALKALIES (%)

	AS RECD	DRY
SODIUM OXIDE	0.187	0.208
POTASSIUM OXIDE	0.007	0.008

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
SAMPLE T-0-90

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 1392.70 GRAMS

		WEIGHT GRAMS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	; RETAINED ON 8 MESH	4.50	0.32	99.68	0.32
PASSING 8 MESH	; RETAINED ON 16 MESH	52.80	3.79	95.88	4.12
PASSING 16 MESH	; RETAINED ON 28 MESH	249.60	17.93	77.95	22.05
PASSING 28 MESH	; RETAINED ON 50 MESH	606.40	43.57	34.38	65.62
PASSING 50 MESH	; RETAINED ON 100 MESH	248.00	17.82	16.57	83.43
PASSING 100 MESH	; RETAINED ON 200 MESH	129.50	9.30	7.26	92.74
PASSING 200 MESH	; RETAINED ON PAN	101.10	7.26	0.00	100.00

TOTAL RECOVERED WEIGHT: 1391.90
PER CENT RECOVERY: 99.94

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT
GRAB SAMPLE
SAMPLE T090

JOB NO.:6303-931055- 2
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.81	
ASH	8.69	9.64
VOLATILE	36.85	40.86
FIXED C	44.65	49.50
TOTAL	100.00	100.00
SULFUR	0.94	1.04
BTU/LB	10051	11144
MAFBTU		12333

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.81	
ASH	8.69	9.64
SULFUR	0.94	1.04
NITROGEN	0.94	1.04
CARBON	59.88	66.39
HYDROGEN	3.79	4.20
OXYGEN	15.95	17.69
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	0.04	0.04
PYRITIC	0.27	0.30
ORGANIC	0.63	0.70
TOTAL	0.94	1.04

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.76
LBS ASH/MM BTU	8.65
LBS SULFUR/MM BTU	0.94

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

FLOAT AND SINK ANALYSIS

DRY BASIS

SAMPLE SOURCE : SAMPLE T090 BULK WASH
FRACTION SIZE : TOP X 0
INITIAL WT. : 483.00 GRAMS

SYNCOAL
6303-931055
20-OCT-93

S#	SPECIFIC GRAVITY	FRACTION ANALYSIS DRY BASIS					CUMULATIVE RECOVERY FLOAT				CUMULATIVE REJECT SINK			
		*WT.	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU
3	FLOAT-1.30	20.20	4.3	11.64	0.87	10839	4.3	11.64	0.87	10839	100.0	9.71	1.02	11031
4	1.30-1.40	416.00	87.8	7.79	0.76	11290	92.0	7.97	0.77	11269	95.7	9.62	1.03	11040
5	1.40-1.50	19.70	4.2	18.59	2.32	9858	96.2	8.43	0.83	11208	8.0	29.81	3.96	8281
6	1.50-1.60	7.60	1.6	28.50	3.46	8370	97.8	8.76	0.88	11162	3.8	42.10	5.76	6556
7	1.60-1.80	4.70	1.0	36.15	3.57	7090	98.8	9.03	0.90	11121	2.2	52.03	7.44	5230
8	1.80-SINK	5.70	1.2	65.13	10.63	3695	100.0	9.71	1.02	11031	1.2	65.13	10.63	3695

RECOVERED WT: 473.90 GRAMS

*--WEIGHT IN GRAMS

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE T090 BULK WASH
FLOAT-1.30
TOP X 0

JOB NO.:6303-931055- 3
LOCATION:CASPER, WY
CHEMIST: JKH

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.62	
ASH	10.52	11.64
VOLATILE	36.52	40.41
FIXED C	43.34	47.95
	------	------
TOTAL	100.00	100.00
SULFUR	0.79	0.87
BTU/LB	9796	10839
MAFBTU		12267

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.82
LBS ASH/MM BTU	10.74
LBS SULFUR/MM BTU	0.81

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SL does not guarantee any results of its services but has agreed to use its best efforts, in accordance with the standards and

DARD LABORATORIES, INC.

JOB NO.:6303-931055- 4
LOCATION:CASPER, WY
CHEMIST: [illegible]

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE T090 BULK WASH
1.40-1.50

JOB NO.:6303-931055- 5
LOCATION:CASPER, WY
CHEMIST: ASH

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.38	
ASH	16.85	18.59
VOLATILE	32.89	36.29
FIXED C	40.88	45.12
	------	------
TOTAL	100.00	100.00
SULFUR	2.10	2.32
BTU/LB	8933	9858
MAFBTU		12109

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	10.50
LBS ASH/MM BTU	18.86
LBS SULFUR/MM BTU	2.35

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
AMPLE T090 BULK WASH
.50-1.60

JOB NO.:6303-931055- 6
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.77	
ASH	26.00	28.50
VOLATILE	29.58	32.42
FIXED C	35.65	39.08
TOTAL	100.00	100.00
SULFUR	3.16	3.46
BTU/LB	7636	8370
MAFBTU		11707

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	11.48
LBS ASH/MM BTU	34.05
LBS SULFUR/MM BTU	4.14

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES,INC.

20-OCT-93

SYNCOAL
SAMPLE T090 BULK WASH
1.60-1.80

JOB NO.:6303-931055- 7
LOCATION:CASPER, WY
CHEMIST: MR

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.35	
ASH	33.13	36.15
VOLATILE	28.15	30.72
FIXED C	30.37	33.13
	------	------
TOTAL	100.00	100.00
SULFUR	3.27	3.57
BTU/LB	6498	7090
MAFBTU		11105

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	12.85
LBS ASH/MM BTU	50.98
LBS SULFUR/MM BTU	5.03

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SL does not ... but has agreed to use its best efforts, in accordance with the standards and

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
SAMPLE T090 BULK WASH
.80-SINK

JOB NO.:6303-931055- B
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	3.08	
ASH	63.12	65.13
VOLATILE	16.69	17.22
FIXED C	17.11	17.65
	------	------
TOTAL	100.00	100.00
SULFUR	10.30	10.63
BTU/LB	3581	3695
MAFBTU		10598

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	8.60
LBS ASH/MM BTU	176.22
LBS SULFUR/MM BTU	28.76

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

931055

IOB #		AIR DRY LOSS	RESDL MOIST	AS RECVD MOIST	AS RECVD ASH	DRY ASH	AS RECVD VM	DRY VM	AS RECVD FC	DRY FC	AS RECVD SULF	DRY SULF	AS RECVD BTU	DRY BTU	MAF BTU
31055	1	2.52	7.94	10.26	9.49	10.57	36.33	40.48	43.92	48.95	1.06	1.18	9914	11048	12354
SAMPLE T090			BULK SAMPLE												
31055	2	2.67	7.34	9.81	8.69	9.64	36.85	40.86	44.65	49.50	0.94	1.04	10051	11144	12333
SAMPLE T090			GRAB SAMPLE												
31055	3	0.00	9.62	9.62	10.52	11.64	0.00	0.00	0.00	0.00	0.79	0.87	9796	10839	12267
	FLOAT-1.30														
31055	4	0.00	9.49	9.49	7.05	7.79	0.00	0.00	0.00	0.00	0.69	0.76	10219	11290	12244
	1.30-1.40														
31055	5	0.00	9.38	9.38	16.85	18.59	0.00	0.00	0.00	0.00	2.10	2.32	8933	9858	12109
	1.40-1.50														
31055	6	0.00	8.77	8.77	26.00	28.50	0.00	0.00	0.00	0.00	3.16	3.46	7636	8370	11707
	1.50-1.60														
31055	7	0.00	8.35	8.35	33.13	36.15	0.00	0.00	0.00	0.00	3.27	3.57	6498	7090	11105
	1.60-1.80														
31055	8	0.00	3.08	3.08	63.12	65.13	0.00	0.00	0.00	0.00	10.30	10.63	3581	3695	10598
	1.80-SINK														

STANDARD LABORATORIES,INC.

20-OCT-93

YNCOAL
IGNITE PROJECT

AMPLE C14

JOB NO.:6303-931056- 1
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	10.94	
ASH	6.91	7.76
VOLATILE	36.11	40.55
FIXED C	46.04	51.69
	------	------
TOTAL	100.00	100.00
SULFUR	0.89	1.00
BTU/LB	10239	11497
MAFBTU		12464

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	10.94	
ASH	6.91	7.76
SULFUR	0.89	1.00
NITROGEN	0.93	1.04
CARBON	60.68	68.13
HYDROGEN	3.78	4.24
OXYGEN	15.87	17.83
	------	------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	0.03	0.03
PYRITIC	0.27	0.30
ORGANIC	0.59	0.67
	------	------
TOTAL	0.89	1.00

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	10.68
LBS ASH/MM BTU	6.75
LBS SULFUR/MM BTU	0.87

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
C14

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 989.00 GRAMS

		WEIGHT GRAMS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	; RETAINED ON 8 MESH	1.30	0.13	99.87	0.13
PASSING 8 MESH	; RETAINED ON 16 MESH	35.20	3.56	96.31	3.69
PASSING 16 MESH	; RETAINED ON 28 MESH	317.80	32.14	64.17	35.83
PASSING 28 MESH	; RETAINED ON 50 MESH	398.60	40.31	23.86	76.14
PASSING 50 MESH	; RETAINED ON 100 MESH	166.60	16.85	7.01	92.99
PASSING 100 MESH	; RETAINED ON 200 MESH	50.30	5.09	1.92	98.08
PASSING 200 MESH	; RETAINED ON PAN	19.00	1.92	0.00	100.00

TOTAL RECOVERED WEIGHT: 988.80
PER CENT RECOVERY: 99.98

STANDARD LABORATORIES, INC.

20-OCT-93

:YNCOAL
IGNITE PROJECT

AMPLE C16

JOB NO.:6303-931056- 2
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
1OISTURE	8.77	
ASH	8.86	9.71
JOLATILE	35.89	39.34
FIXED C	46.48	50.95
	------	------
TOTAL	100.00	100.00
SULFUR	1.35	1.48
BTU/LB	10327	11320
MAFBTU		12537

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	8.77	
ASH	8.86	9.71
SULFUR	1.35	1.48
NITROGEN	0.98	1.08
CARBON	61.17	67.05
HYDROGEN	3.76	4.12
OXYGEN	15.11	16.56
	------	------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
ULFATE	0.04	0.04
YRITIC	0.55	0.60
RGANIC	0.76	0.84
	------	------
DTAL	1.35	1.48

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	8.49
LBS ASH/MM BTU	8.58
LBS SULFUR/MM BTU	1.31

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
C16

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 1027.80 GRAMS

		WEIGHT GRAMS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	; RETAINED ON 8 MESH	0.30	0.03	99.97	0.03
PASSING 8 MESH	; RETAINED ON 16 MESH	19.40	1.89	98.08	1.92
PASSING 16 MESH	; RETAINED ON 28 MESH	196.10	19.09	79.00	21.00
PASSING 28 MESH	; RETAINED ON 50 MESH	266.20	25.91	53.09	46.91
PASSING 50 MESH	; RETAINED ON 100 MESH	289.90	28.21	24.88	75.12
PASSING 100 MESH	; RETAINED ON 200 MESH	130.10	12.66	12.21	87.79
PASSING 200 MESH	; RETAINED ON PAN	125.50	12.21	0.00	100.00

TOTAL RECOVERED WEIGHT: 1027.50
PER CENT RECOVERY: 99.97

STANDARD LABORATORIES, INC.

20-OCT-93

YNCOAL
GNITE PROJECT

MPLE C18

JOB NO.:6303-931056- 3
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
OISTURE	3.52	
ASH	8.56	8.87
OLATILE	39.23	40.66
IXED C	48.69	50.47
	------	------
TOTAL	100.00	100.00
SULFUR	1.14	1.18
TU/LB	10873	11270
MAFBTU		12367

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	3.52	
ASH	8.56	8.87
SULFUR	1.14	1.18
NITROGEN	1.11	1.15
CARBON	64.79	67.15
HYDROGEN	4.07	4.22
OXYGEN	16.81	17.43
	------	------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
LFATE	0.03	0.03
RITIC	0.40	0.42
GANIC	0.71	0.73
	------	------
TAL	1.14	1.18

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	3.24
LBS ASH/MM BTU	7.87
LBS SULFUR/MM BTU	1.05

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
C18

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 971.80 GRAMS

		WEIGHT GRAMS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	; RETAINED ON 8 MESH	3.90	0.40	99.60	0.40
PASSING 8 MESH	; RETAINED ON 16 MESH	35.70	3.68	95.92	4.08
PASSING 16 MESH	; RETAINED ON 28 MESH	162.30	16.71	79.22	20.78
PASSING 28 MESH	; RETAINED ON 50 MESH	364.70	37.54	41.67	58.33
PASSING 50 MESH	; RETAINED ON 100 MESH	253.60	26.11	15.57	84.43
PASSING 100 MESH	; RETAINED ON 200 MESH	112.00	11.53	4.04	95.96
PASSING 200 MESH	; RETAINED ON PAN	39.20	4.04	0.00	100.00

TOTAL RECOVERED WEIGHT: 971.40
PER CENT RECOVERY: 99.96

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
LIGNITE PROJECT

SAMPLE C20

JOB NO.:6303-931056- 4
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	0.92	
ASH	8.38	8.46
VOLATILE	40.56	40.94
FIXED C	50.14	50.60
	------	------
TOTAL	100.00	100.00
SULFUR	1.01	1.02
BTU/LB	11233	11337
MAFBTU		12395

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	0.92	
ASH	8.38	8.46
SULFUR	1.01	1.02
NITROGEN	1.07	1.08
CARBON	66.62	67.24
HYDROGEN	4.28	4.32
OXYGEN	17.72	17.88
	------	------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	0.02	0.02
PYRITIC	0.31	0.31
ORGANIC	0.68	0.69
	------	------
TOTAL	1.01	1.02

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	0.82
LBS ASH/MM BTU	7.46
LBS SULFUR/MM BTU	0.90

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL
LIGNITE COAL, SEPTEMBER 1993
C20

DRY SCREEN ANALYSIS

INITIAL WEIGHT: 992.60 GRAMS

		WEIGHT GRAMS	WEIGHT %	CUMULATIVE % PASSING	CUMULATIVE % RETAINED
PASSING TOP	; RETAINED ON 8 MESH	5.80	0.58	99.42	0.58
PASSING 8 MESH	; RETAINED ON 16 MESH	53.00	5.34	94.07	5.93
PASSING 16 MESH	; RETAINED ON 28 MESH	254.20	25.61	68.46	31.54
PASSING 28 MESH	; RETAINED ON 50 MESH	509.00	51.29	17.17	82.83
PASSING 50 MESH	; RETAINED ON 100 MESH	121.10	12.20	4.97	95.03
PASSING 100 MESH	; RETAINED ON 200 MESH	41.80	4.21	0.76	99.24
PASSING 200 MESH	; RETAINED ON PAN	7.50	0.76	0.00	100.00

TOTAL RECOVERED WEIGHT: 992.40
PER CENT RECOVERY: 99.98

STANDARD LABORATORIES, INC.

20-OCT-93

SYNCOAL
IGNITE PROJECT

JOB NO.:6303-931056- 5
LOCATION:CASPER, WY
CHEMIST: [signature]

AMPLE C22

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.96	
ASH	14.42	16.02
VOLATILE	34.84	38.69
FIXED C	40.78	45.29
	------	------
TOTAL	100.00	100.00
SULFUR	0.83	0.92
BTU/LB	9217	10236
MAFBTU		12189

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.96	
ASH	14.42	16.02
SULFUR	0.83	0.92
NITROGEN	0.92	1.02
CARBON	54.95	61.03
HYDROGEN	3.54	3.93
OXYGEN	15.38	17.08
	------	------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

	AS RECD	DRY
ULFATE	0.06	0.07
YRITIC	0.25	0.28
RGANIC	0.52	0.57
	------	------
OTAL	0.83	0.92

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	10.81
LBS ASH/MM BTU	15.64
LBS SULFUR/MM BTU	0.90

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

SYNCOAL
LIGNITE COAL, SEPTEMBER 19
C22

STANDARD LABORATORIES, INC.

JOB #	AIR DRY LOSS	RESDL MOIST	AS RECVD MOIST	AS RECVD ASH	DRY ASH	AS RECVD VM	DRY VM	AS RECVD FC	DRY FC	AS RECVD SULF	DRY SULF	AS RECVD BTU	DRY BTU	MAF BTU
931056 1 SAMPLE C14	3.93	7.30	10.94	6.91	7.76	36.11	40.55	46.04	51.69	0.89	1.00	10239	11497	12464
31056 2 SAMPLE C16	2.54	6.39	8.77	8.86	9.71	35.89	39.34	46.48	50.95	1.35	1.48	10327	11320	12537
31056 3 SAMPLE C18	-0.30	3.81	3.52	8.56	8.87	39.23	40.66	48.69	50.47	1.14	1.18	10873	11270	12367
31056 4 SAMPLE C20	-1.69	2.57	0.92	8.38	8.46	40.56	40.94	50.14	50.60	1.01	1.02	11233	11337	12385
31056 5 SAMPLE C22	2.15	7.98	9.96	14.42	16.02	34.84	38.69	40.78	45.29	0.83	0.92	9217	10236	12189
31056 6 SAMPLE R41	7.80	11.71	18.60	5.88	7.22	35.53	43.65	39.99	49.13	0.74	0.91	9228	11337	12219
31056 7 SAMPLE R42	5.87	12.19	17.34	6.24	7.55	35.90	43.43	40.52	49.02	0.88	1.06	9311	11265	12185

Rosebud SynCoal Partnership

MEMORANDUM

TO: Art Viall

FROM: Ray Sheldon

DATE: November 18, 1993

c:	Jim Kelly	Jeff Richards	Cliff Groombridge
	Tom Rossetto	Brad Nelson	Test File 9336

RE: Comments - Final Test Report - DEMO 9336 - BNI Lignite

The test report documenting DEMO 9336, the BNI Lignite test performed on September 20, 1993, was very well prepared. The mass balance, plant observations and general analysis were well organized and understood.

I detected some confusion with regard to the washability analyses and the interpreted impact of these results. I had observed during the process test that "excess -6 mesh coal was being sent to waste." The product and waste analyses demonstrated the validity of this observation with 70.14% of the waste less than 8 mesh and only 27.4% of the waste reporting to the greater than 1.5 specific gravity fraction.

As per the attached worksheet, the normalized mass balance shows 40.4% to cleaned product, 11.9% to fines and 13.4% to waste. If the minus 8 mesh waste is included with the product, the clean product yield jumps to 49.8% and the waste drops to 4.0%. The impact of this is a loss of 81 Btu/lb and an increase of 0.01% sulfur in the product. This increase in yield raises the total Btu recovery in the clean product to 75.5% from 61.7% (total product including fines, 92.2% from 78.4%) and decreases the Btu loss to cleaning system waste from 18.7% down to 4.7%. The Btu balance has a 2.9% unaccounted for loss. I feel these additional interpretations can be valuable in analyzing the proposed project.

The sulfur balance indicated an unaccounted for loss of 20.8% of the total sulfur input to the system. Since the mass and Btu balances came within 5%, this large loss seems abnormal. The lost weight of sulfur appears to be about 2/3 pyritic and 1/3 organic from the data. I don't have a good explanation for this observation. Sample error is an obvious one but unlikely to be the total problem due to the good mass and Btu balances. I would welcome any additional ideas and/or comments.

Center SynCoal Project
BNI Lignite Test – 9/20/93

		Feed	Product	Fines	Waste	Waste –8m	Adj Product	Adj Waste	Consolidate Waste +8m
Sulfur Forms – AR									
Pyritic		0.48	0.19	0.30	1.65				
Organic		0.59	0.58	0.73	1.41				
Total		1.07	0.77	1.06	3.06	0.83	0.78	8.30	7.76
BTU/lb –AR		7,064	10,799	9,914	9,841	10,370	10,718	8,598	8,273
SO2/MMBTU									
Pyritic		1.36	0.35	0.61	3.35				
Organic		1.67	1.07	1.47	2.87				
Total		3.03	1.43	2.14	6.22	1.60	1.46	19.30	18.77
						70.14%			
Mass Balance – Normal		100	40.4	11.9	13.4	9.4	49.8	4.0	4.0
lbs of S		1.07	0.31	0.13	0.41	0.08	0.39	0.33	0.31
Balance	0.22	1.07	–0.31	–0.13	–0.41				
Percent	20.8%	100.0%	29.1%	11.8%	38.3%	7.3%	36.3%	31.0%	29.0%
lbs of S – pyr		0.48	0.08	0.04	0.22				
Balance	0.15	0.48	–0.08	–0.04	–0.22				
Percent	30.5%	100.0%	16.0%	7.5%	46.0%				
lbs of S – org		0.59	0.23	0.09	0.19				
Balance	0.08	0.59	–0.23	–0.09	–0.19				
Percent	13.6%	100.0%	39.7%	14.8%	32.0%				
MMBTU/ton		14.13	8.72	2.36	2.64	1.95	10.67	0.69	0.66
Balance	0.41	14.13	–8.72	–2.36	–2.64	–1.95	–10.67	–0.69	–0.66
Percent	2.9%	100.0%	61.7%	16.7%	18.7%	13.8%	75.5%	4.9%	4.7%

Rosebud SynCoal Partnership

MEMORANDUM

TO:	John Gramza Stu Libby	Dick Schwalbe Roger Gazur	Alan Hurlbut

FROM: Ray Sheldon

DATE: November 18, 1993

c:	Jim Kelly Jim Milkovich	Merrill Lewis Chuck Reichert	Steve Wolf Brad Nelson	Tom Rossetto Jeff Richards

RE: Transmittal of Final Test Report
DEMO9336 BNI Lignite Test - September 20, 1993

This memo transmits the final test report for the September 20, 1993 ACCP demonstration facility process test on the BNI lignite feedstock.

I have also attached a memorandum with my comments regarding further interpretation of the washability analyses and their impact on the mass balance, product yield and Btu recovery.

Please call me if you have any questions or comments in Billings at 406/252-2277.

rs-0543.mem

Western SynCoal Company
MEMORANDUM

TO: Jim Kelly
FROM: Art Viall *aV*
DATE: July 8, 1993
c: Bill Ruzynski, Ray Sheldon, Cliff Groombridge, Jeff Richards
Brad Nelson, Tom Rossetto, Test File 9326
SUBJECT: Final Test Report - DEMO9326 - BNI Lignite.

ABSTRACT

The ACCP facility successfully processed about 190 tons of BNI lignite on May 27, 1993. The product from the BNI lignite feedstock contained about 4% moisture and had a heating value of about 11,130 BTU/lb (59% increase). Sulfur was reduced by approximately 58% on a MMBTU basis.

Approximately 45 tons of the processed BNI lignite product was air stabilized and remains at the ACCP facility.

The change in raw coal feedstock was made on-line with no interruption of coal feed to the process. The process was switched back to Rosebud coal at the end of the test again without interruption of coal feed to the process. Very good control of the process was maintained throughout the test.

TEST OBJECTIVES

The objectives for this test were:

1. Determine the effectiveness of the ACCP Demonstration plant in processing on BNI lignite.
2. Determine a rough mass balance for BNI lignite in the ACCP process.
3. Determine raw BNI lignite handling characteristics.
4. Determine BNI lignite process dust characteristics.
5. Determine product coal stability including WPG tests and pile monitoring.

PLANT CONFIGURATION

The plant was configured for single train (even side) operation with the outlet ductwork blanked off on all gas loops at locations were the odd trains commons with the even train ductwork. One first stage fan was inoperable and blanked off, and the other odd train fans were idling with dampers shut. The north first stage bag house inlet was blanked-off with bags removed. The south direct contact condenser process gas and water flow paths were valved out.

The processed product was conveyed off C-13 which is a temporary conveyor, to facilitate filling tote bins and trucks.

TEST CONDUCT (as accomplished)

A copy of the signed-off test procedure as conducted is included in the test file.

The ACCP plant was at normal operating conditions. The even train surge bin, T-92 was filled to 90% with Rosebud coal while the 1000 ton raw coal storage bin, T-91, was allowed to run out. Rosebud coal was sparingly fed at the infeed, screened, and passed through T-91 and into T-92 to maintain 70-90% in the surge bin. When the BNI lignite arrived, the infeed was completely cleared of Rosebud coal, T-91 was allowed to completely empty, and the gate feeding T-92, G-32, was closed. Truckloads of BNI lignite were dumped directly into the infeed hopper, screened, and then loaded into T-91.

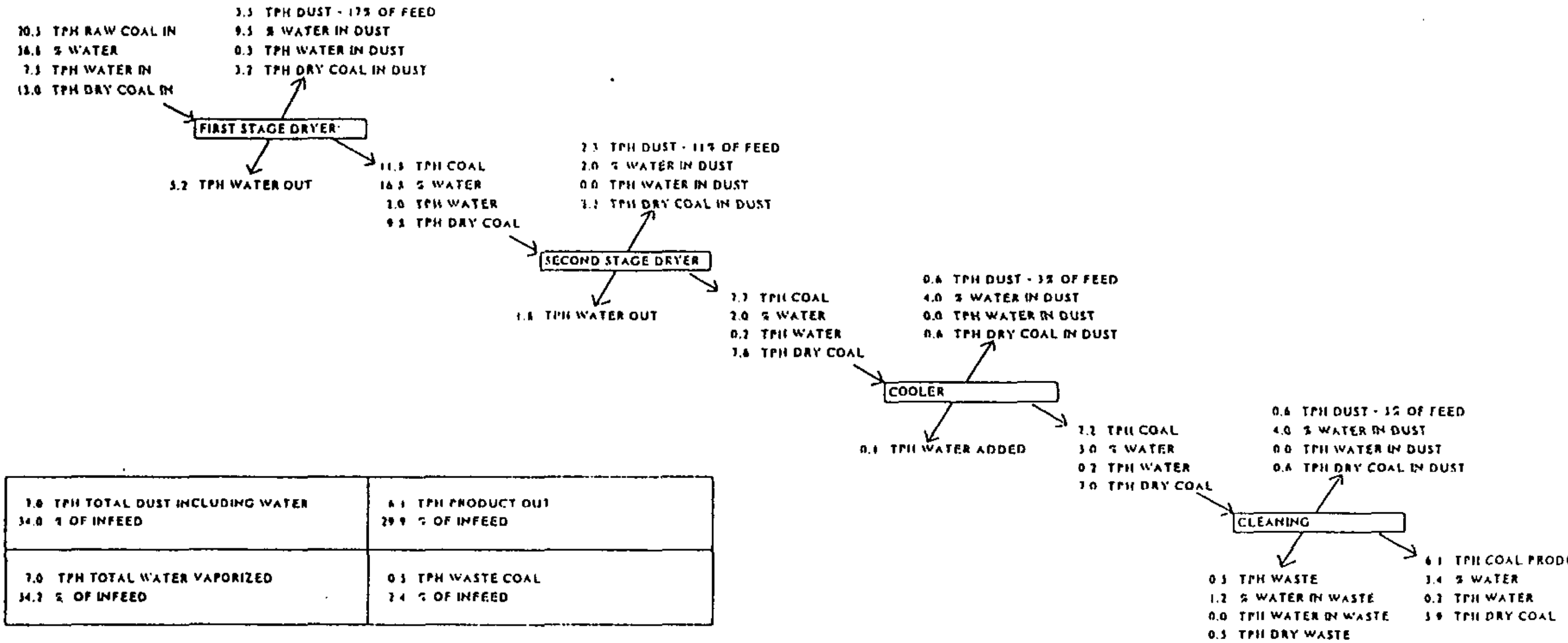
Once the screening of BNI lignite commenced, there was no feed to T-92 and it began drawing down as the Rosebud coal was fed to the drying system. When T-92 level dropped to about 10% the process experienced a small upset (first stage temperatures gained about 25°F) probably due to either starving the process of coal or feeding poor quality coal that had been hung-up on the sides of T-92. When T-92 level dropped to 0%, the BNI lignite was fed to T-92. When T-92 level reads 0%, about 15 ton of coal remains in the cone of the bin so for about an hour a blend of increasing BNI lignite and decreasing Rosebud coal was fed to the process.

Because of the blending, the effect of the BNI lignite entering the process was very slow to develop. The first sign of BNI lignite in the process was a change in odor of the gasses leaking from the process.

About 50 minutes after the first BNI lignite was fed to T-92, an increase in first stage dust production was noted and the feed rate was reduced from 25 TPH to about 16 TPH. At about the same time, the first stage temperatures had climbed to a point were action had to be taken to increase the heat load on the first stage loop. Indications pointed to less efficient than normal heat transfer in the first stage dryer. The first stage dryer weir was raised from 20° to 40° with the intent of holding the coal longer in the first stage dryer. By the time these two adjustments were made (about 1 hour after the first BNI lignite was fed to T-92), first stage and second stage temperatures were about 50°F higher than normal.

Over a period of about 1 1/2 hours the infeed rate was slowly increased and the natural gas firing rate was reduced until normal operating conditions were obtained. For the remainder of the test, only minimal adjustments were required to maintain steady state conditions.

FIGURE I
ACCP MASS BALANCE
WITH BNI LIGNITE FEEDSTOCK



7.0 TPH TOTAL DUST INCLUDING WATER 34.0 % OF INFEED	6.1 TPH PRODUCT OUT 29.9 % OF INFEED
7.0 TPH TOTAL WATER VAPORIZED 34.2 % OF INFEED	0.5 TPH WASTE COAL 2.4 % OF INFEED

Assumptions: Percent dust production as a function of infeed rate are estimates.
Second stage dryer and cooler outlet moistures are estimates.
The amount of water reabsorption in cooling and cleaning steps is estimated.

The cleaning system was relatively unaffected by the change in feedstock. No adjustments were made to the equipment.

Sampling commenced after steady state conditions were obtained and continued for about three hours. Twice, the time to collect a full tote-bin (120 ft^3 portable container) was measured to determine production rate. The contents of the two tote-bins were then used to make test piles to check product stability.

The sealed flask stability test was conducted twice on the product coal to measure stability.

About 45 ton of product coal from the test was hauled by truck to a laydown area were it was dumped in a single layer 12"-24" deep.

Once the required sampling was completed the process was returned to Rosebud coal feedstock with minimal adjustments.

OBSERVATIONS AND RESULTS

ACCP Process Conditions

The plant responded very well throughout the test.

While processing BNI lignite, the process mass balance shifted slightly from that of the Rosebud feedstock, producing more dust and, as expected, more vaporized water. Approximately 30% of the BNI lignite in-feed rate was recovered as product compared to about 48% with Rosebud feedstock (See Figure 1). About 34% of the in-feed rate was produced as dust compared to about 24% with Rosebud feedstock. The remaining 36% was output in the form of vaporized water and the small waste coal stream from the cleaning system compared to about 28% with Rosebud feed stock.

The largest adjustment made to the process was a reduction of coal in-feed rate. The BNI lignite in-feed rate was reduced to a point were drying duty and dust production were nearly the same as when processing Rosebud feedstock. Data sheets from the Plant Control System typical of the process when feeding both BNI lignite and Rosebud coal are attached. (see Attachment 1)

Gas analysis was performed during the test on first and second stage drying gas and the cooling gas. First stage gas chemistry and cooler gas chemistry was substantially unaffected by the change in feedstock. This is not unexpected because the first stage chemistry is held steady by the combustion gases from the furnace. The cooler gas chemistry is also relatively unaffected by feedstock due to a first stage gas purge into the cooler loop and because very little chemistry occurs in the cooler loop. The second stage chemistry did show some variations during the test. Shortly after switching feedstocks, second stage gas oxygen concentration was reduced by about 1.5% (dry basis) and the CO_2 concentration was elevated by about 6% (dry basis). The oxygen concentration returned to typical readings before the end of the test but the CO_2 concentration stabilized at about 3% over typical readings. Both of these concentration variations were probably caused by some combination of a more reactive coal at that stage in the process, an overshoot in second stage temperatures, and a longer residence time for the coal in the second stage dryer.

Coal and Dust Handling

The raw BNI lignite was prescreened before shipment to Colstrip; greatly reducing the potential for handling problems and none were realized.

The BNI product coal was slightly less dense than the product from Rosebud feedstock (about 37 lb/ft^3 compared to about 40 lb/ft^3). The product was not dusty exiting the cleaning system. Attrition testing should be conducted on the product from any additional tests.

The process dust from the BNI lignite did not present any unusual handling problems.

Product Stability

The processed BNI lignite product stability was nearly identical to the processed Rosebud product stability. The processed BNI lignite product gave an average WPG index of 43 which is identical to the Rosebud product index.

The two test piles of product exhibited typical spontaneous heating and reached over 220°F in less than 24 hours. Spontaneous combustion (smoking) began after about 48 hours. The spontaneous heating and combustion observed was typical of the product from Rosebud feedstock.

The larger stockpile of product from BNI lignite stabilized after a minimum of handling but had to be smoothed to about 12" deep before it began cooling. One edge of the stockpile did ignite but after removing the hot portion, the remainder of the product stabilized.

Coal Upgrading Potential

Tables 1 though 3 contain the summary coal analysis. Attachment 2 contains the complete coal analysis.

The product from the BNI lignite feedstock contained about 4% moisture and had a heating value of about 11,130 BTU/lb (59% increase). The coal analysis indicated about 1.9 lb SO_2/MMBTU in the product coal but subsequent samples of air stabilized product make the accuracy of the sulfur data questionable and indicate that the actual sulfur content may have been lower. The spread of sulfur concentrations in the samples was probably due to large pyrite "nuggets" in the streams. A 58% reduction in sulfur can be calculated by using the average lb SO_2/MMBTU for the infeed coal and product.

Washability Analysis

Cursory float and sink washability analyses were performed on the processed BNI lignite product, prior to cleaning (C-5-06, sample 9326-13) and after cleaning (C-9-08, sample 9326-12) with the ACCP air separation system. The results indicate that the ACCP cleaning system was successful at separating the heavier fractions, with good cleaning in the 1.80 specific gravity range. Approximately 3.5% of the product exists in the 1.80 specific gravity or heavier range prior to cleaning, while only 0.6% remained in that range after cleaning. This was accomplished without adjustment of the ACCP equipment and without achieving optimum bed depths. It should be noted that the ACCP cleaning system was designed for 40 tph of product but was only supplied approximately 6 tph of coal during the test. The results prior to cleaning also indicate that extremely good cleaning is possible. A coal product that has less than 10% of the weight within a 0.10 specific gravity spread exhibits excellent separation (cleaning) capability. The results from the dried BNI product indicate that a near compliance product containing 0.7% Sulfur and 11,500 btu/lb is achievable with a separation at 1.40 specific gravity.

Future test work should include analyses above 1.40 specific gravity (1.25 and 1.35) if cleaning of the BNI lignite product is required to be optimized.

RECOMMENDATIONS

The test objectives were met for this test but prior to designing a facility to process BNI lignite, at least one additional test will be required. Rather than determining if the existing facility will process BNI lignite, the test would supply data for designing a BNI lignite processing facility. The main objective for an additional test would be to determine a complete mass and energy balance for processing BNI lignite at several conditions. The emphasis would be on stable process conditions, sampling, and determining dust and product flow rates at the numerous locations in the process.

SUMMARY

The process is very effective and efficient on BNI lignite. The process mass balance shifted slightly from the Rosebud feedstock, producing more dust and, as expected, more vaporized water. No unusual handling problems were realized with either the BNI lignite raw feed or the process dust. The processed BNI lignite product has about the same stability as processed Rosebud coal product.

Table 1 - DEMO9326 Coal Product Analysis

Parameter	Composite Test Sample	BNI Analyzed Sample	5 Day Air Stabilized Sample	11 Day Air Stabilized Sample	18 Day Air Stabilized Sample	Average
% Moisture	3.4	4.1	4.6	5.9	6.2	4.84
% Volatile Matter	40.0	39.7	NA	NA	NA	39.85
% Fixed Carbon	47.8	48.5	NA	NA	NA	48.15
% Ash	8.7	7.7	7.2	7.5	7.8	7.78
% Sulfur	1.37	0.74	0.73	0.76	0.91	0.90
BTU/lb	11,136	11,126	10,887	10,791	10,660	10,920.00
Lb SO_2/MMBTU	2.46	1.33	1.34	1.41	1.71	1.65
Lb Ash/MMBTU	7.8	6.9	6.6	7.0	7.3	7.12
MAF BTU/lb	12,426	12,615	12,344	12,460	12,395	12,448.00
MAF % VM	45.5	45.0	NA	NA	NA	45.25
MAF % FC	54.4	55.0	NA	NA	NA	54.70

Table 2 - DEMO9326 Raw Coal Analysis

Parameter	Composite Test Sample	BNI Analyzed Sample 1	BNI Analyzed Sample 2	BNI Analyzed Sample 3	Average
% Moisture	35.2	37.8	37.0	37.2	36.80
% Volatile Matter	27.1	27.2	26.6	26.9	26.95
% Fixed Carbon	29.6	30.0	29.4	29.7	29.68
% Ash	8.0	5.0	7.1	6.3	6.60
% Sulfur	2.2	0.71	1.8	0.82	1.38
BTU/lb	7,049	7,022	6,944	6,949	6,991.00
Lb SO_2/MMBTU	6.24	2.02	5.18	2.36	3.95
Lb Ash/MMBTU	11.3	7.1	10.2	9.1	9.43
MAF BTU/lb	12,410	12,276	12,422	12,299	12,351.75
MAF % VM	47.7	47.6	47.6	47.6	47.63
MAF % FC	52.1	52.4	52.6	52.6	52.43

Table 3 - DEMO9326 Coal Analysis of Composite Test Samples

Parameter	Raw Lignite Feed	Processed Lignite Product - Cleaned	Processed Lignite Product - Uncleaned	Minus 6 Mesh Product	6 mesh x 1/4" Product	1/4"x 1/2" Product	Cleaning System Waste	First Stage Dryer Product	Process Dust Composite Note 1	First Stage Dust	Second Stage/ Cooler Dust	Cleaning System Dust
% Moisture	35.2	3.4	3.5	2.7	3.1	4.2	1.2	16.8	6.1	9.5	2.2	5.6
% Ash	8.0	8.7	9.5	6.2	7.1	8.4	44.1	8.9	9.8	10.0	9.2	12.0
% Sulfur	2.18	1.37	1.79	0.79	0.63	0.81	22.6	1.42	1.05	1.01	0.96	1.75
BTU/lb	7,049	11,136	10,959	11,580	11,347	10,961	6,215	9,177	10,404	9,836	11,075	10,437
MAF BTU/lb	12,426	12,670	12,594	12,717	12,633	12,532	11,362	12,348	12,376	12,221	12,504	12,671
Lb SO_2/MMBTU	6.19	2.46	3.27	1.36	1.11	1.48	72.7	3.09	2.02	2.05	1.73	3.35
Lb Ash/MMBTU	11.3	7.8	8.7	5.4	6.3	7.7	71	9.7	9.5	10.2	8.3	11.5
% VM	27.1	40.0	39.3	40.8	40.1	39.4	26.9	35.1	38.2	36.8	40.3	35.9
MAF % VM	47.7	45.5	45.2	44.8	44.7	45.1	49.2	47.2	45.4	45.7	45.5	43.6
% Fixed C	29.6	47.8	47.8	50.3	49.7	48.0	27.8	39.3	45.9	43.7	48.3	46.5
MAF % Fixed C	52.1	54.4	54.9	55.2	55.3	54.9	50.8	52.9	54.6	54.3	54.5	56.4

Note 1: Process dust composite data is weighted 50% for 1st stage dust, 42% for 2nd stage and cooler dust, and 8% for cleaning system dust. These percentages are estimates.

ATTACHMENT 1

ATTACHMENT 2

STANDARD LABORATORIES

25-JUN-93

SYNCOAL

LIGNITE W76 Raw CoAl
?326-1
* ANALYZED USING ASTM D3175 FOR SPARKING FUELS

JOB NO.:6303-930488- 1
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	35.23		33.72
ASH	8.04	12.42	8.23
*VOLATILE	27.09	41.82	27.72
FIXED C	29.64	45.76	30.33
TOTAL	100.00	100.00	100.00
SULFUR	2.18	3.36	2.23
BTU/LB	7049	10883	7213
MAFBTU		12426	

EQUILIBRIUM MOISTURE (%)

33.72

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	35.23		33.72
ASH	8.04	12.42	8.23
SULFUR	2.18	3.36	2.23
NITROGEN	0.63	0.97	0.64
CARBON	41.36	63.86	42.33
HYDROGEN	2.69	4.15	2.75
OXYGEN	9.87	15.24	10.10
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.18
SILICON DIOXIDE	9.66
FERRIC OXIDE	26.49
ALUMINUM OXIDE	6.41
TITANIUM DIOXIDE	0.25
MANGANESE DIOXIDE	0.08
CALCIUM OXIDE	16.35
MAGNESIUM OXIDE	3.69
POTASSIUM OXIDE	0.24
SODIUM OXIDE	2.86
SULFUR TRIOXIDE	27.00
BARIUM OXIDE	0.24
STRONTIUM OXIDE	0.40
UNDETERMINED	6.15
TOTAL	100.00

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	<0.01	<0.01
PYRITIC	1.35	2.09
ORGANIC	0.83	1.27
TOTAL	2.18	3.36

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

AIR DRY LOSS	15.35
LBS H2O/MM BTU	49.98
LBS ASH/MM BTU	11.41
LBS SULFUR/MM BTU	3.09
BASE/ACID RATIO	3.04
T250	2900+ DEG F
SILICA RATIO	17.15
% ALKALI AS NA2O	0.47

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL

ATTENTION: ART VIALL

JOB NUMBER: 930488
BULK DENSITY

21-Jun-93
LOCATION: CASPER, WY
CHEMIST: SHA

	SAMPLE	CLIENT ID.	BULK DENSITY (LBS/CU. FT.)
Raw Coal →	1	9326-1	44
	2	9326-3	36.8

STANDARD LABORATORIES, INC.

SYNCOAL
SIZE ANALYSIS
9326-1 Raw Coal
21-JUN-93

JOB NO.: 930488
CHEMIST: SRH
LOCATION: CASPER, WY.

DRY SCREEN ANALYSIS

INITIAL WEIGHT 7450.00 GRAMS

					WEIGHT GRAMS	WEIGHT %	CUMULATIVE WEIGHT %
PASSING	TOP	;	RETAINED ON	1 1/2" RD.	0.00	0.00	0.00
PASSING	1 1/2" RD.	;	RETAINED ON	1" RD.	2045.70	27.53	27.53
PASSING	1" RD.	;	RETAINED ON	3/4" RD.	3008.10	40.48	68.01
PASSING	3/4" RD.	;	RETAINED ON	1/2" RD.	1507.50	20.29	88.29
PASSING	1/2" RD.	;	RETAINED ON	1/4" RD.	576.70	7.76	96.05
PASSING	1/4" RD.	;	RETAINED ON	PAN	293.50	3.95	100.00

TOTAL RECOVERED WEIGHT: 7431.50
PER CENT RECOVERY: 99.75

STANDARD LABORATORIES,...C.

SYNCOAL

LIGNITE C-6 Uncleaned Product
9326-2

JOB NO.:6303-930490- 2
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	3.48	
ASH	9.50	9.84
VOLATILE	39.26	40.68
FIXED C	47.76	49.48
	-------	-------
TOTAL	100.00	100.00
SULFUR	1.79	1.85
BTU/LB	10959	11354
MAFBTU		12594

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	3.48	
ASH	9.50	9.84
SULFUR	1.79	1.85
NITROGEN	0.91	0.94
CARBON	64.46	66.78
HYDROGEN	4.27	4.42
OXYGEN	15.59	16.17
	-------	-------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	3.18
LBS ASH/MM BTU	8.67
LBS SULFUR/MM BTU	[illegible]

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GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

25-JUN-93

SYNCOAL

LIGNITE C-9-08 Cleaned Product
9326-3
* ANALYZED USING ASTM D3175 FOR SPARKING FUELS

JOB NO.:6303-930488- 2
LOCATION:CASPER, WY
CHEMIST:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	3.39		20.14
ASH	8.73	9.04	7.22
*VOLATILE	40.04	41.45	33.10
FIXED C	47.84	49.51	39.54
TOTAL	100.00	100.00	100.00
SULFUR	1.37	1.42	1.13
BTU/LB	11136	11527	9205
MAFBTU		12672	

EQUILIBRIUM MOISTURE (%)

20.14

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	3.39		20.14
ASH	8.73	9.04	7.22
SULFUR	1.37	1.42	1.13
NITROGEN	0.86	0.89	0.71
CARBON	65.27	67.56	53.95
HYDROGEN	4.31	4.46	3.56
OXYGEN	16.07	16.63	13.29
TOTAL	100.00	100.00	100.00
CHLORINE	<0.01	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

PHOSPHORUS PENTOXIDE	0.96
SILICON DIOXIDE	13.92
FERRIC OXIDE	13.36
ALUMINUM OXIDE	8.15
TITANIUM DIOXIDE	0.33
MANGANESE DIOXIDE	0.11
CALCIUM OXIDE	22.90
MAGNESIUM OXIDE	5.01
POTASSIUM OXIDE	0.41
SODIUM OXIDE	6.96
SULFUR TRIOXIDE	22.30
BARIUM OXIDE	0.22
STRONTIUM OXIDE	0.56
UNDETERMINED	4.81
TOTAL	100.00

FORMS OF SULFUR (%)

	AS RECD	DRY
SULFATE	<0.01	<0.01
PYRITIC	0.54	0.56
ORGANIC	0.83	0.86
TOTAL	1.37	1.42

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	3.04
LBS ASH/MM BTU	7.84
LBS SULFUR/MM BTU	1.23
BASE/ACID RATIO	2.17
T250	1941 DEG F
SILICA RATIO	25.[illegible]
% ALKALI AS NA2O	0.[illegible]

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIE IC.

SYNCOAL

ATTENTION: ART VIALL

JOB NUMBER: 930488
BULK DENSITY

21-Jun-93
LOCATION: CASPER, WY
CHEMIST:

SAMPLE	CLIENT ID.	BULK DENSITY (LBS/CU. FT.)
1	9326-1	44
Cleaned Product → 2	9326-3	36.8

STANDARD LABORATORIES

SYNCOAL
SIZE ANALYSIS
9326-3 Cleaned Product
21-JUN-93

JOB NO.: 930488
CHEMIST: SRH
LOCATION: CASPER, WY.

DRY SCREEN ANALYSIS

INITIAL WEIGHT 6383.30 GRAMS

				WEIGHT GRAMS	WEIGHT %	CUMULATIVE WEIGHT %
PASSING	TOP	; RETAINED ON	1/2" RD.	10.80	0.17	0.17
PASSING	1/2" RD.	; RETAINED ON	4 MESH	204.00	3.20	3.37
PASSING	4 MESH	; RETAINED ON	8 MESH	1742.10	27.30	30.66
PASSING	8 MESH	; RETAINED ON	14 MESH	3103.20	48.62	79.28
PASSING	14 MESH	; RETAINED ON	20 MESH	841.40	13.18	92.47
PASSING	20 MESH	; RETAINED ON	40 MESH	431.20	6.76	99.22
PASSING	40 MESH	; RETAINED ON	100 MESH	36.70	0.58	99.80
PASSING	100 MESH	; RETAINED ON	PAN	12.80	0.20	100.00

TOTAL RECOVERED WEIGHT: 6382.20
PER CENT RECOVERY: 99.98

STANDARD LABORATORIES.

7 JUN 93

SYNCOAL

LIGNITE C-9 Waste Coal From
9326-4 cleaning System

JOB NO.14303-93490- 4
LOCATION:CASPER, WY
CHEMIST: jcd

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	1.20	
ASH	44.09	44.63
VOLATILE	26.91	27.24
FIXED C	27.80	28.13
TOTAL	100.00	100.00
SULFUR	22.64	22.92
BTU/LB	6215	6291
MAFBTU		11362

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	1.20	
ASH	44.09	44.63
SULFUR	22.64	22.92
NITROGEN	0.44	0.45
CARBON	31.49	31.87
HYDROGEN	2.19	2.22
OXYGEN	-2.05	-2.09
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	1.93
LBS ASH/MM BTU	70.93
LBS SULFUR/MM BTU	36.4[illegible]

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GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES

~~9 JUN 93~~

SYNCOAL

LIGNITE C-18   First Stage Dust
9326-5

JOB NO.:6303-930490- 7
LOCATION:CASPER, WY
CHEMIST: [illegible]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.53	
ASH	9.99	11.04
VOLATILE	36.76	40.63
FIXED C	43.72	48.33
	-------	-------
TOTAL	100.00	100.00
SULFUR	1.01	1.12
BTU/LB	9836	10872
MAFBTU		12221

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	9.53	
ASH	9.99	11.04
SULFUR	1.01	1.12
NITROGEN	1.00	1.11
CARBON	58.95	65.16
HYDROGEN	3.82	4.22
OXYGEN	15.70	17.35
	-------	-------
TOTAL	100.00	100.00
CHLORINE	<0.01	<0.01

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	9.69
LBS ASH/MM BTU	10.16
LBS SULFUR/MM BTU	1.03

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JUN 14 1993

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIE[illegible] [illegible]C.

SYNCOAL

LIGNITE T-97 second stage and cooler [illegible]
°326-6

JOB NO. 14303-93[illegible] 1
LOCATION: CASPER, [illegible]
CHEMIST: [illegible]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	2.22	
ASH	9.20	9.41
VOLATILE	40.32	41.24
FIXED C	48.26	49.35
TOTAL	100.00	100.00
SULFUR	0.96	0.98
BTU/LB	11075	11327
MAFBTU		12504

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	2.22	
ASH	9.20	9.41
SULFUR	[illegible]	[illegible]
NITROGEN	[illegible]	[illegible]
CARBON	[illegible]	[illegible]
HYDROGEN	[illegible]	[illegible]
OXYGEN	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]
CHLORINE	[illegible]	[illegible]

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU [illegible]
LBS ASH/MM BTU [illegible]
LBS SULFUR/MM BTU [illegible]

RECEIVED
JUN [illegible]

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIE[illegible] [illegible]NC.

SYNCOAL

LIGNITE 0-8-56 cleaning system dust
9326-7

JOB NO.: [illegible]
LOCATION: CASPER, [illegible]
CHEMIST: [illegible]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	5.63	
ASH	11.99	12.71
VOLATILE	35.87	38.01
FIXED C	46.51	49.28
TOTAL	100.00	100.00
SULFUR	1.75	1.86
BTU/LB	10437	11060
MAFBTU		12671

EQUILIBRIUM MOISTURE (%)

ULTIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	5.63	
ASH	11.99	[illegible]
SULFUR	[illegible]	[illegible]
NITROGEN	[illegible]	[illegible]
CARBON	[illegible]	[illegible]
HYDROGEN	[illegible]	[illegible]
OXYGEN	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

MINERAL ANALYSIS OF ASH

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS [illegible]/MM BTU	[illegible]
LBS ASH/MM BTU	[illegible]
LBS SULFUR/MM BTU	[illegible]

RECEIVED
JUN 14 [illegible]

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

SYNCOAL

[illegible] S-23 *[illegible] [illegible] [illegible] [illegible]*
93?A-9

JOB NO. 16303-930490- 9
LOCATION: CASPER, WY
CHEMIST: *[illegible]*

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	2.74	
ASH	6.20	6.38
VOLATILE	40.75	41.90
FIXED C	50.31	51.72
TOTAL	100.00	100.00
SULFUR	[illegible]	0.81
BTU/LB	1358[illegible]	1396[illegible]
MAF BTU		1491[illegible]

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	2.[illegible]
LBS ASH/MM BTU	5.[illegible]
LBS SULFUR/MM BTU	0.6[illegible]

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

DECEIVE[illegible]
[illegible] 1 A[illegible]

SL does not guarantee any results of its services but has agreed to use its best efforts, in accordance with the standards and practices of the industry, to cause such results to be accurate and complete. SL has agreed to hold in confidence all

SYNCOAL

LIGNITE S-24   6 mesh x ¼ product
9326-10

JOB NO.:16303-930490- 5
LOCATION:CASPER, WY
CHEMIST: [signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	3.07	
ASH	7.10	7.33
VOLATILE	40.12	41.39
FIXED C	49.71	51.28
TOTAL	100.00	100.00
SULFUR	0.63	0.65
BTU/LB	11347	11707
MAFBTU		12633

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	2.7[illegible]
LBS ASH/MM BTU	6.2[illegible]
LBS SULFUR/MM BTU	0.5[illegible]

RECEIVED
JUN 14 1993

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES

SYNCOAL

LIGNITE S-23 ¼" x ⅛" product
9326-11

JOB NO.16303-V30490- 9
LOCATION:CASPER, W
CHEMIST: gal

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	[illegible]	
ASH	8.36	9.77
VOLATILE	35.[illegible]	41.14
FIXED C	[illegible]	5[illegible].1[illegible]
TOTAL	10[illegible]	10[illegible]
SULFUR	[illegible]	0.8[illegible]
BTU/LB	[illegible]	1143[illegible]
MAFBTU		[illegible]

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	[illegible]
LBS ASH/MM BTU	[illegible]
LBS SULFUR/MM BTU	[illegible]

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

STANDARD LABORATORIES, INC.

FLOAT AND SINK ANALYSIS

DRY BASIS

SAMPLE SOURCE : C908 CLEAN LIGNITE 9326-12 *cleaned product* SYNCOAL
FRACTION SIZE : TOP X 0 5303-930489
INITIAL WT. : 9482.90 GRAMS 17-JUN-93

			FRACTION ANALYSIS DRY BASIS				CUMULATIVE RECOVERY FLOAT				CUMULATIVE REJECT SINK			
S#	SPECIFIC GRAVITY	*WT.	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU
1	FLOAT - 1.40	8850.00	93.4	6.38	0.65	11677	93.4	6.38	0.65	11677	100.0	7.36	0.83	11524
2	1.40 - 1.50	424.10	4.5	17.07	0.91	10523	97.8	6.47	0.66	11629	6.6	21.48	3.32	9272
3	1.50 - 1.60	103.70	1.1	28.29	2.00	9146	98.9	6.90	0.68	11582	2.2	38.84	[illegible]	7006
4	1.60 - 1.80	45.80	0.5	40.80	4.24	6739	99.4	7.05	[illegible]	[illegible]	1.1	53.14	[illegible]	[illegible]
5	1.80 - SINK	36.10	0.4	[illegible]	24.21	7575	100.0	[illegible]	[illegible]	[illegible]	0.4	60.77	[illegible]	[illegible]

RECOVERED WT: 9479.70 GRAMS

*--WEIGHT IN GRAMS

SYNCOAL
6303-930489
June 17, 1993

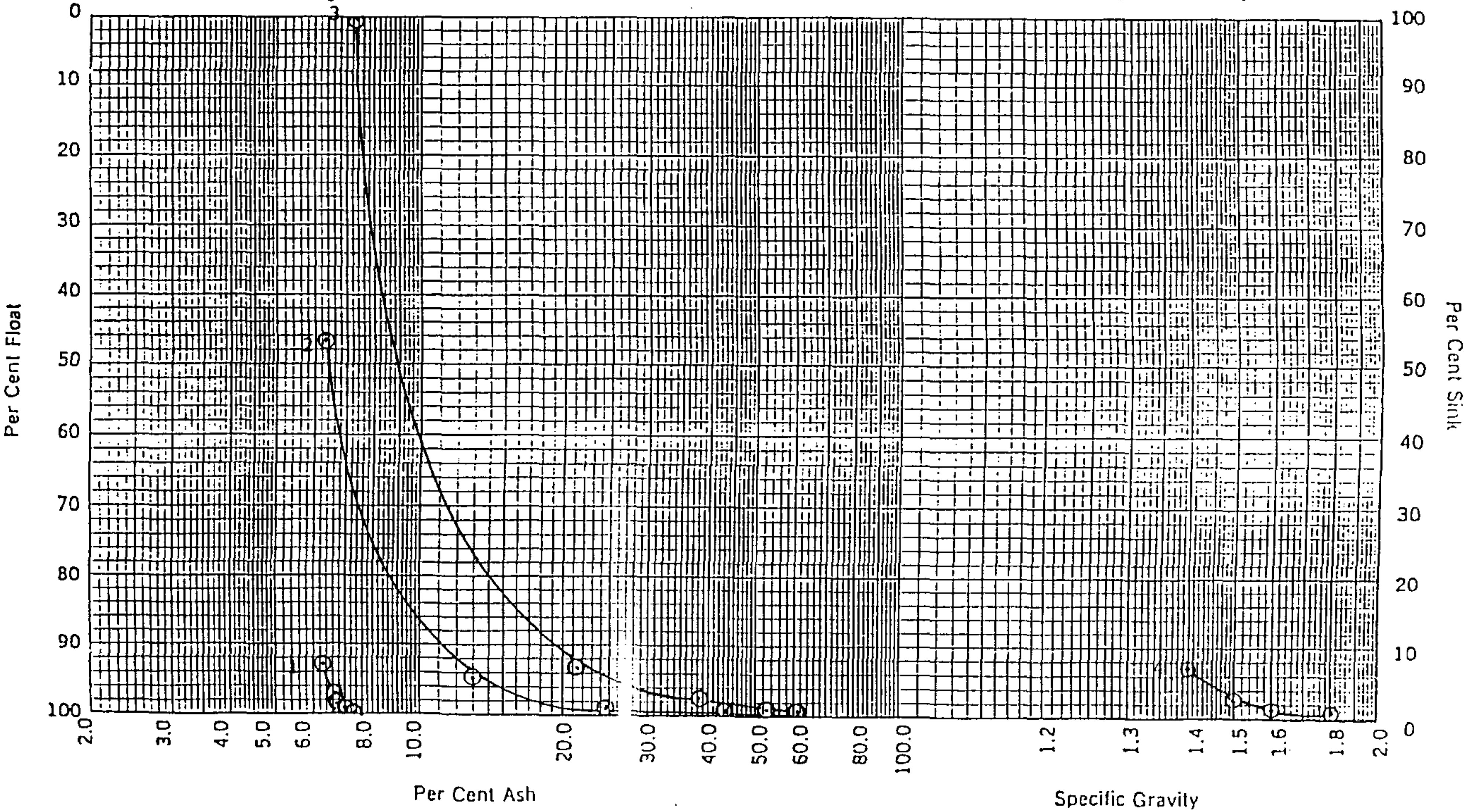
ANALYTICAL REPORT

SAMPLE SOURCE: C908 Clean Lignite
9326-12

WASHABILITY CURVES

FRACTION SIZE: Top X O   INITIAL WT.: 9482.90 Grams

1. Cumulative Coal - Ash
2. Coal Characteristic - Ash
3. Cumulative Refuse - Ash
4. Yield - Specific Gravity



STANDARD LABORATORIES.

FLOAT AND SINK ANALYSIS

DRY BASIS

SAMPLE SOURCE : C506 LIGNITE TEST 9326-13 *uncleaned product* SYNCOAL
FRACTION SIZE : TOP X 0 6303-930489
INITIAL WT. : 10335.00 GRAMS 17-JUN-93

			FRACTION ANALYSIS DRY BASIS				CUMULATIVE RECOVERY FLOAT				CUMULATIVE REJECT SINK			
S#	SPECIFIC GRAVITY	*WT.	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU	%WT	%ASH	%S	BTU
6	FLOAT - 1.40	9700.60	94.0	6.71	0.72	11511	94.0	6.71	0.72	11511	100.0	9.06	1.86	11165
7	1.40 - 1.50	146.10	1.4	17.33	1.30	10091	95.4	6.87	0.73	11490	6.0	45.71	19.69	5766
8	1.50 - 1.60	63.10	0.6	27.51	2.56	8897	96.0	7.00	0.74	11473	4.6	54.41	25.33	4440
9	1.60 - 1.80	51.80	0.5	42.20	4.82	6738	96.5	7.18	0.76	11449	4.0	58.52	28.80	3759
10	1.80 - SINK	361.40	3.5	60.86	32.24	3332	100.0	9.06	1.86	11165	3.5	60.86	32.24	3332

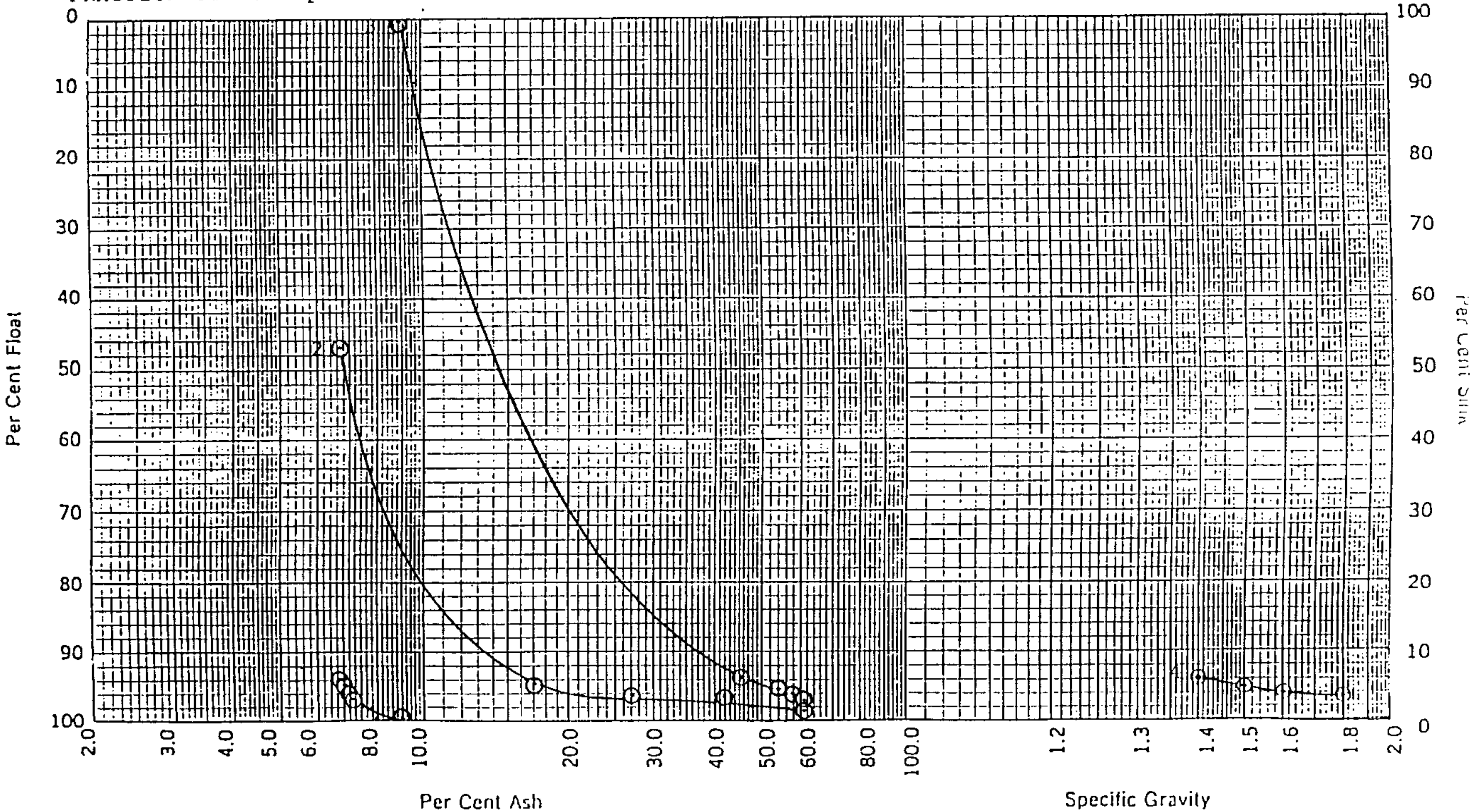
RECOVERED WT: 10323.00 GRAMS

*--WEIGHT IN GRAMS

SYNCOAL
6303-930489
June 17, 1993
SAMPLE SOURCE: C506 Lignite Test
9326-13
FRACTION SIZE: Top X 0   INITIAL WT.: 10335.00 Grams

ANALYTICAL REPORT

WASHABILITY CURVES



STANDARD LABORATORIES, ...

8-JUN-93

SYNCOAL

LIGNITE R-42 First Stage Dryer Discharge
9326-14

JOB NO.:6303-930490- 3
LOCATION:CASPER, WY
CHEMIST: [illegible signature]

PROXIMATE ANALYSIS (%)

	AS RECD	DRY
MOISTURE	16.80	
ASH	8.88	10.67
VOLATILE	35.07	42.15
FIXED C	39.25	47.18
	------	------
TOTAL	100.00	100.00
SULFUR	1.42	1.71
BTU/LB	9177	11030
MAFBTU		12348

ULTIMATE ANALYSIS (%)

MINERAL ANALYSIS OF ASH (%)

EQUILIBRIUM MOISTURE (%)

FORMS OF SULFUR (%)

FUSION TEMPERATURE OF ASH (F)

ADDITIONAL DATA

LBS H2O/MM BTU	18.31
LBS ASH/MM BTU	9.68
LBS SULFUR/MM BTU	1.55

RECEIVE

GRINDABILITY (HGI)

WATER SOLUBLE ALKALIES (%)

Lab Sample ID 713

WECO COAL ANALYSIS REQUEST/REPORT

Origin: ACCP X Other_____ A____ B____ C____ D____

Sample Number 1326-17

Sample Description 18-day Air Sub./210 (include coordinates for inpit samples)

Date(s) Collected 6/14/93

Date Delivered__________ By__________

Time Delivered__________ Received by__________

Analysis Requested: X Short Prox ___Moisture Only ___Size Analysis
___Reabsorption ___Other__________

Gross Sample Weight__________

SHORT PROX RESULTS

Results:	As Received	Dry Basis
% Moisture	6.22	----
% Ash	7.81	8.33
% Sulfur	0.91	0.97
BTU/lb	10660	11367

MAF BTU/lb 12399
lb Sulfur/MM BTU ~~1.19~~ 1.71

Screen Analysis Results

Size	Weight %	Cumulative % Passing	Cumulative Retained

Please state screen mesh size

Date Reported 6-14-93
By TL

Comments Do not Air dry

jam/72/0818

APPENDIX D-2

SVEDALA HOLO-FLITE TEST DATA

TEST REPORT

SVEDALA
PUMPS & PROCESS

NUMBER 96 - P 44018
DATE March 1, 1996
AUTHOR Tom Saunders

SUBJECT: Test report on the DENVER 7" Holo-Flite™ using samples of coarse lignite coal.

LOCATION: COLORADO SPRINGS, CO

DATE(S): February 9, 1996

RECEIVING NUMBER: N/A

ORDER NUMBER: 196928

AFD NUMBER: N/A

PRODUCT LINES AFFECTED: HOLO-FLITE

REPORT FOR: ROSEBUD SYNCOAL PARTNERSHIP
P.O. Box 7137
Billings, MT 59101

ATTENTION: Art Viall, P.E.

All recommendations and opinions expressed in this report are based on results obtained in the testing laboratory of the SVEDALA - PUMPS & PROCESS and apply only to the treatment of material conforming to the sample submitted by the subject company. The recommendations for procedures, including flowsheets, reagent uses and other operating details set forth in this report are believed to be available for commercial usage and, in our opinion, will not infringe on any unexpired U.S. patents known to us. However, we have not made an infringement search directed to these recommendations and therefore do not assume any responsibility for this opinion.

TABLE OF CONTENTS

SUBJECT

This is a report of the results of the 7 inch Holo-Flite tests performed on lignite coal from the Rosebud mine. These tests were completed on January 30, 1996.

INTRODUCTION

Ten drums of coarse lignite coal were tested on January 29, 1996 and January 30, 1996. Additional test work on finer coal is scheduled for March 26, 1996.

Primary test objectives were as follows:

- o Dry the sample from 35% moisture to 18% water
- o Determine the heat transfer coefficient
- o Maximize through-put
- o Maximize heat transfer
- o Investigate material handling characteristics
- o Determine start and running torque.
- o Establish product temperature required to achieve 18% and 2% moisture

RECOMMENDATIONS by Jerry Levad

This is an excellent application for drying lignite coal containing 35% moisture. All sizes of multi-screw Holo-Flite Processors are recommended.

An overall U-value of 8 is recommended for drying from 38 percent to 2.0 percent water at peripheral screws speeds of 4 fpm or greater.

Torque requirements were minimal.

OBSERVATIONS

The test feed for was coal at about 3/4 inch x D.

The test unit required 1400 inch pounds of torque when it was at 600°F without material in the screw. After the screw was filled, and during the test at 38% to 20% moisture 4700 inch pounds of torque were required. Test C-1, from 17% to 2% moisture, the torque requirement was 6100 inch pounds.

The heat transfer coefficient for test run B-1 in the 7 inch Holo-Flite was 8.7 Btu/hr·ft²··°F. The material temperature range of the product from this test was 59°F to 240°F, and the moisture content decreased from 38.2% to 18.6%. A second test, for verification of test B-1 and to produce material for a second pass test, with slightly lower oil temperatures produced a heat transfer coefficient of 9.2 Btu/hr·ft^2·°F, and decreased the product temperature to 226°F. the moisture content of the product for test B-2 was 20.1%.

The heat transfer coefficient of a second pass of the test series B product material through the 7 inch test unit was 7.2 Btu/hr·ft^2·°F. This second pass produced a product containing 2.0% moisture and a product temperature of 339°F from a feed containing 16.9% moisture with a feed temperature of 104°F.

DISCUSSION

Test series A was completed in the 4 inch test unit, to determine parameters for the larger scale tests. Test series B and C were completed in the 7 inch test unit

The test runs were conducted by continuously feeding the material while keeping the control parameters constant. When the product discharge temperature reached equilibrium, all sizing data was collected. Data collected included:

- o Elapsed time
- o Feed weight
- o Oil temperature in/out
- o Material temperature in/out
- o Material moisture in/out
- o Screw speed
- o Bulk density in/out

Torque was measured using a rotary torque transducer manufactured by LeBeau Products Division of the Eaton Corporation.

Material handling observations were recorded.

The material control weir was set at 1/2" above the screw edges.

CALCULATIONS

1. The total heat load was calculated from the heat required to heat the solids and volatile material, and the heat required to evaporate the volatile material.

2. The log mean temperature differential (LMTD) of the system was calculated based on the temperature drop of the heat transfer media through the screws and the material temperature rise differential.

3. The heat transfer coefficient (U) was determined by dividing the total load by the area of the screws and the LMTD.

4. The specific conveyance was calculated by dividing the feed rate of the material in cubic feet per hour by the screw speed and the theoretical conveying capacity.

5. Moisture analysis was conducted in a Denver Instrument Company IR 100 moisture analyzer which determines moisture based on weight loss of a sample heated to a preset temperature when the rate of weight loss decreases to a preset rate.

6. The flow of material in cubic feet per hour was calculated by dividing the feed rate by the bulk weight

7. Residence time was calculated by dividing the trough volume by the flow of material and multiplying by 60.

(1)D0404-2 HOLO-FLITE TEST DATA

<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>

Rosebud
Coal

DATE:	01/26/96	
TRIAL ID NO.:	A-1	
SURFACE AREA:	10.0	Ft^2
SPECIFIC HEAT SOLIDS:	0.3	Btu/lb-°F
SPECIFIC HEAT VOLATILES:	1.0	Btu/lb-°F
BOILING POINT:	201.0	°F
LATENT HEAT:	970.0	Btu/lb
FEED RATE:	485.5	lbs/hr
FEED MOISTURE:	38.2	%
DISCHARGE MOISTURE:	29.7	%
FEED TEMPERATURE:	37.0	°F
DISCHARGE TEMPERATURE:	201.0	°F
OIL TEMP IN:	605.0	°F
OIL TEMP OUT:	594.0	°F
TROUGH VOLUME:	0.6	Cu Ft
THEORETICAL CONVEYANCE:	0.9	CFH/RPM
BULK DENSITY:	47.2	lbs/Cu Ft
FEED RATE:	485.5	lbs/hr
SCREW SPEED:	13.1	RPM
PERIPHERAL VELOCITY:	13.7	FPM

3.3	MIN	RESIDENCE TIME
91.6	%	THEORETICAL CONVEYANCE
300.0	LBS/HR	SOLIDS
185.5	LBS/HR	INITIAL VOLATILES
126.7	LBS/HR	RESIDUAL VOLATILES
58.8	LBS/HR	EVAPORATION
12301.7	BTU/HR	TO HEAT SOLIDS
30415.8	BTU/HR	TO HEAT VOLATILES
57000.1	BTU/HR	EVAPORATION
99717.6	BTU/HR	TOTAL HEAT LOAD
476.4		LMTD
21.0		U-VALUE

***** *******

(1)D0404-2 HOLO-FLITE TEST DATA

<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>

Rosebud
Coal

DATE:	01/29/96	
TRIAL ID NO.:	A-2	
SURFACE AREA:	10.0	Ft^2
SPECIFIC HEAT SOLIDS:	0.3	Btu/lb-°F
SPECIFIC HEAT VOLATILES:	1.0	Btu/lb-°F
BOILING POINT:	201.0	°F
LATENT HEAT:	970.0	Btu/lb
FEED RATE:	256.8	lbs/hr
FEED MOISTURE:	38.2	%
DISCHARGE MOISTURE:	24.1	%
FEED TEMPERATURE:	66.0	°F
DISCHARGE TEMPERATURE:	201.0	°F
OIL TEMP IN:	608.0	°F
OIL TEMP OUT:	602.0	°F
TROUGH VOLUME:	0.6	Cu Ft
THEORETICAL CONVEYANCE:	0.9	CFH/RPM
BULK DENSITY:	49.6	lbs/Cu Ft
FEED RATE:	256.8	lbs/hr
SCREW SPEED:	6.5	RPM
PERIPHERAL VELOCITY:	6.8	FPM

6.6	MIN	RESIDENCE TIME
92.6	%	THEORETICAL CONVEYANCE
158.7	LBS/HR	SOLIDS
98.1	LBS/HR	INITIAL VOLATILES
50.5	LBS/HR	RESIDUAL VOLATILES
47.6	LBS/HR	EVAPORATION
6427.9	BTU/HR	TO HEAT SOLIDS
13244.0	BTU/HR	TO HEAT VOLATILES
46197.5	BTU/HR	EVAPORATION
65869.4	BTU/HR	TOTAL HEAT LOAD
468.5		LMTD
14.1		U-VALUE
	*****	*******

(1)D0404-2 HOLO-FLITE TEST DATA

<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>

Rosebud
Coal

DATE:	01/29/96		
TRIAL ID NO.:	A-3		
SURFACE AREA:	10.0	Ft^2	
SPECIFIC HEAT SOLIDS:	0.3	Btu/lb-°F	
SPECIFIC HEAT VOLATILES:	1.0	Btu/lb-°F	
BOILING POINT:	201.0	°F	
LATENT HEAT:	970.0	Btu/lb	
FEED RATE:	127.7	lbs/hr	
FEED MOISTURE:	38.2	%	
DISCHARGE MOISTURE:	12.6	%	
FEED TEMPERATURE:	65.0	°F	
DISCHARGE TEMPERATURE:	227.0	°F	
OIL TEMP IN:	605.0	°F	
OIL TEMP OUT:	599.0	°F	
TROUGH VOLUME:	0.6	Cu Ft	
THEORETICAL CONVEYANCE:	0.9	CFH/RPM	
BULK DENSITY:	49.6	lbs/Cu Ft	
FEED RATE:	127.7	lbs/hr	
SCREW SPEED:	3.0	RPM	
PERIPHERAL VELOCITY:	3.1	FPM	
	13.4	MIN	RESIDENCE TIME
	100.5	%	THEORETICAL CONVEYANCE
	78.9	LBS/HR	SOLIDS
	48.8	LBS/HR	INITIAL VOLATILES
	11.4	LBS/HR	RESIDUAL VOLATILES
	37.4	LBS/HR	EVAPORATION
	3835.1	BTU/HR	TO HEAT SOLIDS
	6633.6	BTU/HR	TO HEAT VOLATILES
	36268.3	BTU/HR	EVAPORATION
	46737.0	BTU/HR	TOTAL HEAT LOAD
	451.5		LMTD
	10.4		U-VALUE
		*****	*******

1D0710 HOLO-FLITE TEST DATA
<<<<<<<<<<<<<>>>>>>>>>>>>>>

Rosebud
Coal

DATE:	02/05/96		
TRIAL ID NO.:	B-1		
SURFACE AREA:	42.2	Ft^2	
SPECIFIC HEAT SOLIDS:	0.3	Btu/lb-°F	
SPECIFIC HEAT VOLATILES:	1.0	Btu/lb-°F	
BOILING POINT:	201.0	°F	
LATENT HEAT:	977.0	Btu/lb	
FEED RATE:	509.3	lbs/hr	
FEED MOISTURE:	38.2	%	
DISCHARGE MOISTURE:	18.6	%	
FEED TEMPERATURE:	59.0	°F	
DISCHARGE TEMPERATURE:	240.0	°F	
OIL TEMP IN:	613.4	°F	
OIL TEMP OUT:	597.0	°F	
TROUGH VOLUME:	4.5	Cu Ft	
THEORETICAL CONVEYANCE:	7.4	CFH/RPM	
BULK DENSITY:	46.4	lbs/Cu Ft	
FEED RATE:	509.3	lbs/hr	
SCREW SPEED:	2.3	RPM	
PERIPHERAL VELOCITY:	4.2	FPM	
	24.6	MIN	RESIDENCE TIME
	65.4	%	THEORETICAL CONVEYANCE
	314.8	LBS/HR	SOLIDS
	194.6	LBS/HR	INITIAL VOLATILES
	71.9	LBS/HR	RESIDUAL VOLATILES
	122.6	LBS/HR	EVAPORATION
	17091.3	BTU/HR	TO HEAT SOLIDS
	27627.3	BTU/HR	TO HEAT VOLATILES
	119815.3	BTU/HR	EVAPORATION
	164533.9	BTU/HR	TOTAL HEAT LOAD
	450.7		LMTD
	8.7		U-VALUE
		*****	*******

1D0710 HOLO-FLITE TEST DATA

<<<<<<<<<<<<<>>>>>>>>>>>>>

Rosebud
Coal

DATE:	02/05/96		
TRIAL ID NO.:	B-2		
SURFACE AREA:	42.2	Ft^2	
SPECIFIC HEAT SOLIDS:	0.3	Btu/lb-°F	
SPECIFIC HEAT VOLATILES:	1.0	Btu/lb-°F	
BOILING POINT:	201.0	°F	
LATENT HEAT:	977.0	Btu/lb	
FEED RATE:	574.6	lbs/hr	
FEED MOISTURE:	38.2	%	
DISCHARGE MOISTURE:	20.1	%	
FEED TEMPERATURE:	59.0	°F	
DISCHARGE TEMPERATURE:	226.0	°F	
OIL TEMP IN:	609.7	°F	
OIL TEMP OUT:	591.0	°F	
TROUGH VOLUME:	4.5	Cu Ft	
THEORETICAL CONVEYANCE:	7.4	CFH/RPM	
BULK DENSITY:	46.4	lbs/Cu Ft	
FEED RATE:	574.6	lbs/hr	
SCREW SPEED:	2.3	RPM	
PERIPHERAL VELOCITY:	4.2	FPM	
	21.8	MIN	RESIDENCE TIME
	73.8	%	THEORETICAL CONVEYANCE
	355.1	LBS/HR	SOLIDS
	219.5	LBS/HR	INITIAL VOLATILES
	89.3	LBS/HR	RESIDUAL VOLATILES
	130.2	LBS/HR	EVAPORATION
	17791.9	BTU/HR	TO HEAT SOLIDS
	31170.8	BTU/HR	TO HEAT VOLATILES
	127181.0	BTU/HR	EVAPORATION
	176143.6	BTU/HR	TOTAL HEAT LOAD
	453.8		LMTD
	9.2		U-VALUE
		*****	*******

1D0710 HOLO-FLITE TEST DATA

<<<<<<<<<<<<<>>>>>>>>>>>>>

Rosebud
Coal

DATE:	02/05/96	
TRIAL ID NO.:	C-1	
SURFACE AREA:	42.2	Ft^2
SPECIFIC HEAT SOLIDS:	0.3	Btu/lb-°F
SPECIFIC HEAT VOLATILES:	1.0	Btu/lb-°F
BOILING POINT:	201.0	°F
LATENT HEAT:	977.0	Btu/lb
FEED RATE:	509.3	lbs/hr
FEED MOISTURE:	16.9	%
DISCHARGE MOISTURE:	2.0	%
FEED TEMPERATURE:	104.0	°F
DISCHARGE TEMPERATURE:	339.0	°F
OIL TEMP IN:	602.0	°F
OIL TEMP OUT:	615.1	°F
TROUGH VOLUME:	4.5	Cu Ft
THEORETICAL CONVEYANCE:	7.4	CFH/RPM
BULK DENSITY:	46.4	lbs/Cu Ft
FEED RATE:	509.3	lbs/hr
SCREW SPEED:	2.3	RPM
PERIPHERAL VELOCITY:	4.2	FPM

24.6	MIN	RESIDENCE TIME
65.4	%	THEORETICAL CONVEYANCE
423.2	LBS/HR	SOLIDS
86.1	LBS/HR	INITIAL VOLATILES
8.8	LBS/HR	RESIDUAL VOLATILES
77.3	LBS/HR	EVAPORATION
29838.4	BTU/HR	TO HEAT SOLIDS
8349.2	BTU/HR	TO HEAT VOLATILES
75483.3	BTU/HR	EVAPORATION
113670.9	BTU/HR	TOTAL HEAT LOAD
373.4		LMTD
7.2		U-VALUE
	*****	*******

SVEDALA®

FILE COPY
PROJ. # 96-685
FILE # 3.5
COPY TO JAC
GSK

FACSIMILE TRANSMISSION

TO: Unifield Engineering DATE: Oct. 14, 1996

ATTN: Clinton Camper FAX: 406/245-7112

FROM: Jerry Levad PAGES: 16

REF: Western Syncoal - Rosebud
Test Report 96-P-44100

==

An advance copy of the Test Report is attached.

The final copy and video tape will follow as soon as they are available.

Please contact me or our representative if you have any questions.

Regards,

Jerry Levad
Application Engineer

Copy: Camber Process Equipment Company
775 Mariposa Street
Denver, CO 80204
(303) 623-2136

Svedala Industries, Inc.
Pumps & Process
621 S. Sierra Madre (80903) • P.O. Box 340
Colorado Springs, CO 80901
Tel: (719) 471-3443 • Fax: (719) 471-4469
E-Mail: denversala@aol.com

TEST REPORT

96-P-44100

Tom Saunders

SVEDALA

PUMPS & PROCESS

TEST REPORT

TEST NUMBER.	96 P 44100
RECEIVING NUMBER	RN 7969
ORDER NUMBER	
TEST DATES	09/23-27/96
REPORT DATE	10/01/96
TEST MATERIAL	Lignite Coal
TEST EQUIPMENT	D-710 4
APPLICATION	Drying
PRODUCT LINE	Holo-Flite
AUTHOR	Tom Saunders
CUSTOMER	Western Syncoal P. O. Box 7137 Billings, MT 59103
ATTN:	Harry Bonner

TABLE OF CONTENTS

INTRODUCTION

Twenty drums of coal were received from Maxim Technologies in Bismarck, North Dakota on September 12, 1996. This coal is for Holo-Flite drying tests for Western Syncoal Company. This sample was assigned the receiving number RN 7969. Tests were completed on September 26, 1996.

The test objectives were as follows:

- o Dry the sample from 36% moisture to 15% to 18% moisture
- o Dry the product from the above test to less than 2% moisture
- o Maximize temperature differential
- o Screen product grab samples from each of the tests to evaluate degradation of the coal.
- o Determine the heat transfer coefficient
- o Maximize through-put
- o Maximize heat transfer
- o Investigate material handling characteristics

RESULTS

The test goals were met.

Test 1-B-1 decreased the moisture content of the coal from 37.1% moisture to 14.4% moisture. The heat transfer coefficient for this test was 12.5 Btu/hr·ft²·°F. The conveyance for this test was 80.5% of the theoretical conveyance.

Test 1-B-2, a second pass with the product from test 1-B-1 used as feed, decreased the moisture content of the coal from 14.4% moisture to 2.3% moisture. The heat transfer coefficient for this test was 9.5 Btu/hr·ft²·°F. The conveyance for this test was 86.0% of the theoretical conveyance.

Test 1-C-1, with the same test conditions as test 1-B-1, decreased the moisture content of the coal from 37.0% moisture to 15.2% moisture. The heat transfer coefficient for this test was 12.2 Btu/hr·ft²·°F. The conveyance for this test was 84.6% of the theoretical conveyance.

RECOMMENDATIONS by J. Levad

This is an excellent drying application for all sizes of multi-screw Holo-Flite Processors.

A minimum overall U-value of 12.5 is recommended for drying from 36 percent to 15 percent water at peripheral screws speeds greater than 4 fpm.

Although, specific conveyance is good, visual observation disclosed that a lower material bed volume occurs in the last 1/4 of the helix near the discharge end. A possible explanation is that the solids convey better as they become drier. Adding mixing lugs in this area of each screw is recommended to decrease conveyance and increase surface contact.

DATA SUMMARY

HOLO-FLITE

CONVEYANCE DATA SUMMARY

RUN #	SCREW SPEED rpm	FEED BULK DENSITY $\#/ft^3$	FEED RATE #/hr	RESIDENCE TIME min	SPECIFIC CONVEYANCE %	REMARKS
1-B1	2.5	47.2	703	18.1	80.5	Screw 3/4 full
1-B2	2.5	47.1	749	17.0	86.0	Screw full
1-C1	2.5	46.2	723	17.2	84.6	Screw 3/4 full

THERMAL DATA SUMMARY

RUN #	SCREW SPEED rpm	VOLATILE IN/OUT %	MATERIAL TEMPERATURE IN/OUT °F	OIL TEMPERATURE IN/OUT °F	DUTY btu/hr	LMTD	CALCULATED U-VALUE $btu/hr \cdot ft^2 \cdot °F$
1-B1	2.5	37.1/14.4	67/214	600/574.5	238983	444.0	12.46
1-B2	2.5	14.4/2.3	96/314	601/583	155170	378.4	9.49
1-C1	2.5	37.0/15.2	70/214	604/588.5	238090	451.2	12.21

SCREEN ANALYSIS

DENVER WET SCREEN ANALYSIS DATA

WESTERN SYNCOAL FEED

Tyler Mesh	Grams	% wt. on	Cumulative % passing	Cumulative % wt. on
3	0.90	0.28	99.72	0.28
4	28.00	8.67	91.05	8.95
6	52.70	16.32	74.74	25.26
8	46.80	14.49	60.25	39.75
10	40.20	12.45	47.80	52.20
14	38.60	11.95	35.85	64.15
20	25.20	7.80	28.05	71.95
28	22.00	6.81	21.24	78.76
35	7.60	2.35	18.89	81.11
48	13.40	4.15	14.74	85.26
65	15.42	4.77	9.97	90.03
100	4.73	1.46	8.50	91.50
150	5.28	1.63	6.87	93.13
200	2.18	0.67	6.19	93.81
-200	20.00	6.19	-0.00	100.00
TOTAL	323.01	100.00		

WESTERN SYNCOAL 1-B-1 / WESTERN SYNCOAL 1-B-2

Tyler Mesh	1-B-1 Grams	1-B-1 % Wt. on	1-B-1 Cumulative % passing	1-B-1 Cumulative % wt. on	1-B-2 Grams	1-B-2 % Wt. on	1-B-2 Cumulative % passing	1-B-2 Cumulative % wt. on
3	0.80	0.30	99.70	0.30	0.00	0.00	100.00	0.00
4	22.00	8.24	91.46	8.54	6.80	3.4	96.50	3.45
6	59.90	22.44	69.01	30.99	35.00	17.74	78.81	21.19
8	40.50	15.17	53.84	46.16	36.90	18.71	60.11	39.89
10	41.60	15.59	38.25	61.75	34.70	17.59	42.52	57.48
14	29.80	11.17	27.09	72.91	25.10	12.72	29.79	70.21
20	17.30	6.48	20.60	79.40	17.30	8.77	21.02	78.98
28	16.90	6.33	14.27	85.73	13.50	6.84	14.18	85.82
35	8.80	3.30	10.97	89.03	7.00	3.55	10.63	89.37
48	6.80	2.55	8.43	91.57	8.90	4.51	6.12	93.88
65	6.50	2.44	5.99	94.01	0.90	0.46	5.66	94.34
100	2.30	0.86	5.13	94.87	1.70	0.86	4.80	95.20
150	5.30	1.99	3.14	96.8	2.60	1.32	3.48	96.52
200	2.70	1.01	2.13	97.87	1.60	0.81	2.67	97.33
-200	5.69	2.13		100.00	5.27	2.67		100.00
TOTAL	266.89	100	82.63		197.27	100.00		

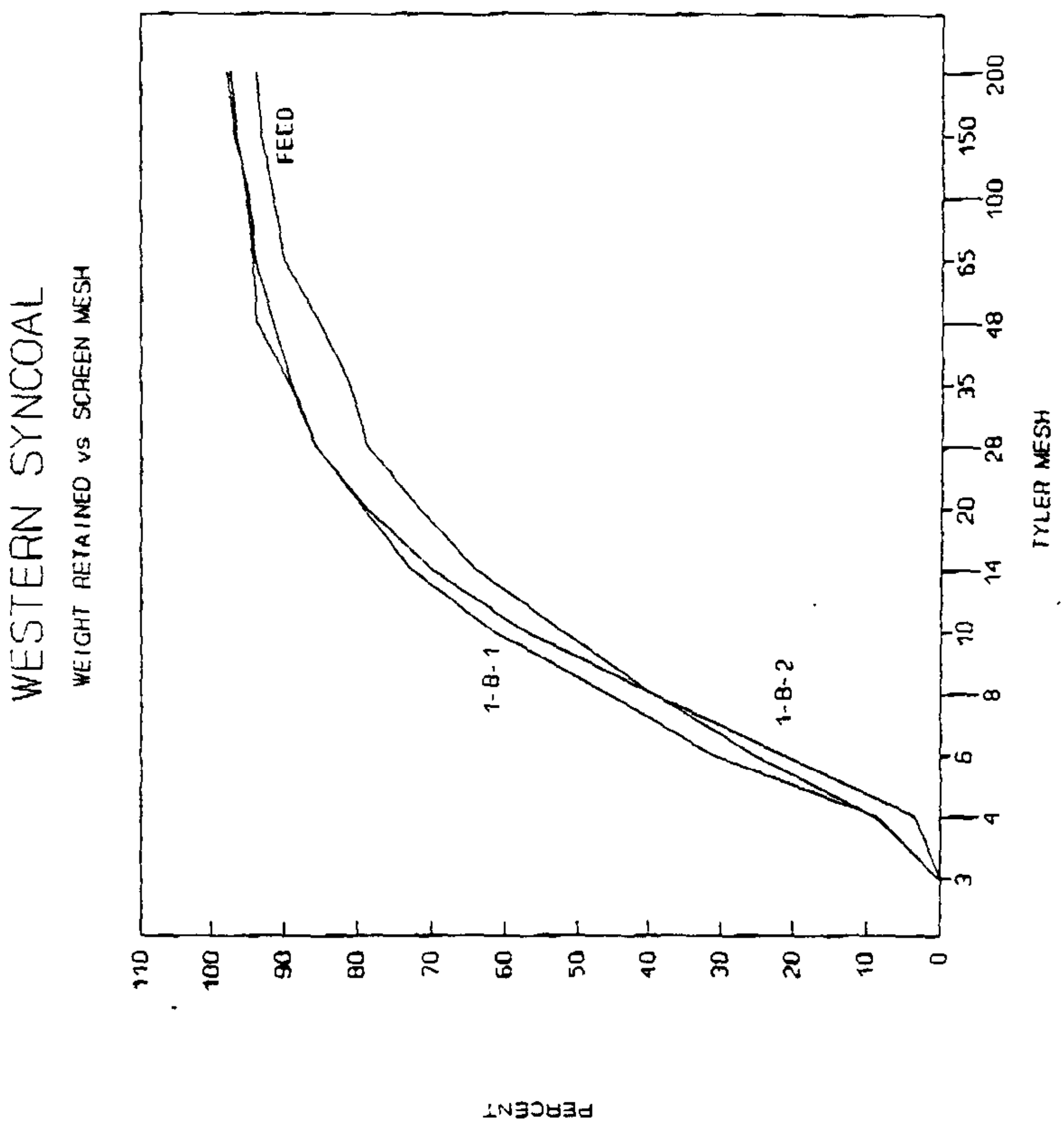


FIGURE 1: SCREEN ANALYSIS

OBSERVATIONS

Test 1-B-1 continued for nearly 2 hours. The screw did not fill in this time. Approximately 3/4 of the screw was full during test 1-C-1. The second pass of the material, test 1-B-2, filled the screw to the drop point.

DISCUSSION

The test runs were conducted by continuously feeding the material while keeping the control parameters constant. When the product discharge temperature reached equilibrium, all sizing data was collected. Data collected included:

- o Elapsed time
- o Feed weight
- o Oil temperature in/out
- o Material temperature in/out
- o Material moisture in/out
- o Screw speed
- o Bulk density in/out

Material handling observations were recorded.

The material control weir was set at one-half inch above the screw edges.

TEST PROCEDURES

- The material is fed to the processor at a constant rate to maintain the bed level at the top of the screws.
- Temperatures are recorded by multiple channel data acquisition using thermocouple inputs.
- Material feed and discharge are measured by the "catch time, and weight" technique
- Moisture content of the material is determined by averaging three samples per container.
- The bulk density of the material is measured by weighing a known volume.
- Specific Heat, latent heat, etc. cannot be determined in the SVEDALA laboratory; this information must be supplied prior to the test.
- Heat transfer calculations will be completed using the Test Data Reduction software.

TEST CONDITIONS

Holo-Flite tests were all conducted with 600°F oil. The screw speed for all tests was 2.5 rpm.

The screen analysis was conducted wet using a Tyler square root of two series.

SAMPLE PROPERTIES

Specific Heat (Solids)	0.30 Btu/lb·°F
Specific Heat (Volatile)	1.0 Btu/lb·°F
Specific Weight (Feed)	0.740
Latent Heat of Vaporization	971 Btu/lb
Boiling Point (Volatile)	201 °F (6000 ft elevation)

CALCULATIONS

HOLO-FLITE

1. The total heat load was calculated from the heat required to heat the solids and volatile material. and the heat required to evaporate the volatile material.

2. The log mean temperature differential (LMTD) of the system was calculated based on the temperature drop of the heat transfer media through the screws and the material temperature rise differential.

3. The heat transfer coefficient (U) was determined by dividing the total load by the area of the screws and the LMTD.

4. The specific conveyance was calculated by dividing the feed rate of the material in cubic feet per hour by the screw speed and the theoretical conveying capacity.

5. Moisture analysis was conducted by weight loss of a sample heated overnight in a 107°F oven with slight air flow through the heating chamber.

6. The flow of material in cubic feet per hour was calculated by dividing the feed rate by the bulk weight.

7. Residence time was calculated by dividing the trough volume by the flow of material and multiplying by 60.

SCREEN ANALYSIS

1. Screen analysis weight percentage recovered on each screen fraction are calculated by dividing the weight on each screen by the total weight recovered and multiplying by 100.

2. Cumulative weight percent retained is determined by adding the recovery on each screen coarser than the screen reported.

3. Percent weight loss is determined by subtracting the total weight recovered from the original weight of the sample. dividing by the original weight of the sample and multiplying by 100.

EQUIPMENT DESCRIPTION

HOLO-FLITE TEST UNIT SPECIFICATIONS

Size of unit	1D710 4
Material contact parts	316 Stainless
Heat transfer area, screws	43.2 sq ft
Theoretical conveying capacity	7.4 cfh/rpm
Trough volume	4.5 cu ft
Heat exchange media	Therminol® 66

SCREEN ANALYSIS

The sample was screened wet using a Tyler square root of two screen series between 3 mesh and 200 mesh.

APPENDIX

7-INCH HOLO-FLITE TEST DATA

<<<<<<<<<<<<<>>>>>>>>>>>>>>>>

TROUGH VOLUME	4.5 Cu Ft	Western Syncoal
THEORETICAL CONVEYANCE	7.4 CFH/RPM	Trial Run #: 1-B-1
SURFACE AREA	43.2 Sq Ft	September 25, 1996
		Lignite Coal
SPECIFIC HEAT SOLIDS	0.30 BTU/lb-°F	
SPECIFIC HEAT VOLATILES	1.00 BTU/lb-°F	
BOILING POINT	201 °F	
LATENT HEAT	971 BTU/lb	
FEED RATE	703 lbs/hr	
FEED MOISTURE	37.1 %	
DISCHARGE MOISTURE	14.4 %	
FEED TEMPERATURE	67 °F	
DISCHARGE TEMPERATURE	214 °F	
OIL TEMPERATURE IN	600 °F	
OIL TEMPERATURE OUT	575 °F	
BULK DENSITY	47 lbs/Cu Ft	
FEED RATE	703 lbs/hr	
SCREW SPEED	2.5 RPM	
PERIPHERAL VELOCITY	4.6 FPM	

18.1 MINUTES	RESIDENCE TIME
80.5 %	SPECIFIC CONVEYANCE
442 LBS/HR	SOLIDS
261 LBS/HR	INITIAL VOLATILES
74 LBS/HR	RESIDUAL VOLATILES
187 LBS/HR	EVAPORATION
19491 BTU/HR	TO HEAT SOLIDS
38337 BTU/HR	TO HEAT VOLATILES
181155 BTU/HR	EVAPORATION
238983 BTU/HR	TOTAL HEAT LOAD
443.98	LMTD
12.46	U-VALUE

****

7-INCH HOLO-FLITE TEST DATA

<<<<<<<<<<<<<>>>>>>>>>>>>>>>

TROUGH VOLUME	4.5 Cu Ft	Western Syncoal
THEORETICAL CONVEYANCE	7.4 CFH/RPM	Trial Run #: 1-B-2
SURFACE AREA	43.2 Sq Ft	September 26, 1996
		Lignite Coal
SPECIFIC HEAT SOLIDS	0.30 BTU/lb-°F	
SPECIFIC HEAT VOLATILES	1.00 BTU/lb-°F	
BOILING POINT	201 °F	
LATENT HEAT	971 BTU/lb	
FEED RATE	749 lbs/hr	
FEED MOISTURE	14.4 %	
DISCHARGE MOISTURE	2.3 %	
FEED TEMPERATURE	96 °F	
DISCHARGE TEMPERATURE	314 °F	
OIL TEMPERATURE IN	601 °F	
OIL TEMPERATURE OUT	583 °F	
BULK DENSITY	47 lbs/Cu Ft	
FEED RATE	749 lbs/hr	
SCREW SPEED	2.5 RPM	
PERIPHERAL VELOCITY	4.6 FPM	

17.0 MINUTES	RESIDENCE TIME
86.0 %	SPECIFIC CONVEYANCE
641 LBS/HR	SOLIDS
108 LBS/HR	INITIAL VOLATILES
15 LBS/HR	RESIDUAL VOLATILES
92 LBS/HR	EVAPORATION
	(X)
42020 BTU/HR	TO HEAT SOLIDS
23524 BTU/HR	TO HEAT VOLATILES
89626 BTU/HR	EVAPORATION
155170 BTU/HR	TOTAL HEAT LOAD
378.44	LMTD
9.49	U-VALUE

****

7-INCH HOLO-FLITE TEST DATA

<<<<<<<<<<<<<>>>>>>>>>>>>>>>

TROUGH VOLUME	4.5 Cu Ft	Western Syncoal
THEORETICAL CONVEYANCE	7.4 CFH/RPM	Trial Run #: 1-C-1
SURFACE AREA	43.2 Sq Ft	September 26, 1996
		Lignite Coal
SPECIFIC HEAT SOLIDS	0.30 BTU/lb-°F	
SPECIFIC HEAT VOLATILES	1.00 BTU/lb-°F	
BOILING POINT	201 °F	
LATENT HEAT	971 BTU/lb	
FEED RATE	723 lbs/hr	
FEED MOISTURE	37.0 %	
DISCHARGE MOISTURE	15.2 %	
FEED TEMPERATURE	70 °F	
DISCHARGE TEMPERATURE	214 °F	
OIL TEMPERATURE IN	604 °F	
OIL TEMPERATURE OUT	589 °F	
BULK DENSITY	46 lbs/Cu Ft	
FEED RATE	723 lbs/hr	
SCREW SPEED	2.5 RPM	
PERIPHERAL VELOCITY	4.6 FPM	

17.2 MINUTES	RESIDENCE TIME
84.6 %	SPECIFIC CONVEYANCE
456 LBS/HR	SOLIDS
267 LBS/HR	INITIAL VOLATILES
82 LBS/HR	RESIDUAL VOLATILES
185 LBS/HR	EVAPORATION
19682 BTU/HR	TO HEAT SOLIDS
38448 BTU/HR	TO HEAT VOLATILES
179960 BTU/HR	EVAPORATION
238090 BTU/HR	TOTAL HEAT LOAD
451.2	LMTD
12.21	U-VALUE

****

APPENDIX D-3

CARRIER TEST DATA

MEMORANDUM

TO: Steve Wolf

FROM: Art Viall
DATE: March 3, 1994

CC: Jeff Richards
Ray Sheldon
Brad Nelson

RE: TESTING AT CARRIER - MARCH 1&2, 1994

The testing conducted at Carrier this week was successful, but all of the test objectives were not met. The simulation of the first stage dryer with and without in-bed heat exchange tubes was completed. All of the objectives related to the first stage drying were completed with the exception of determining percent fines carryover without expanded freeboard. The proposed design for the first stage dryer was validated. I expect some minor changes to Carrier's quote related to the first stage dryer but they should not be significant.

The simulation of the second stage dryer was not attempted this week. The planned method of simulation was not possible. An alternative approach has been proposed that requires minor equipment modifications.

All of the test runs were conducted using Carrier's 2.5 ft^2 pilot fluid bed. The tests lasted between 45 and 90 minutes. The attached table summarizes the test runs. The data presented is not exact and has not been checked but gives a good representation.

The in-bed heat exchange test was not successful. The concept did not yield good results on the pilot scale (and would unlikely yield positive results on the full scale) because:

- Very low heat transfer coefficients were realized due to large particle sizes. The U valve was not measurable in the test unit because the steam flow rate was to low to measure.

- The tubes interfere with fluidization causing slugging and possible slumping in the bed. The slugging results in higher dP through the bed (ie higher HP). The tubes also decrease the direct heat transfer between the fluidizing gas and the coal due to slugs of gas surging through the bed without enough contact with coal to exchange its heat. The slugging also appeared to increase the fines carryover rate.

- The risk of slumping the bed is increased and recovering from a slumped (plugged) bed will be very difficult with in-bed tubes present.

With in-bed tubes designed for the course feed the last two concerns will be decreased, but it is unlikely that good heat transfer will ever be realized with course coal.

For the first test run, the unit was rigged with a directionally drilled deck (DDD). It was a simple perforated deck but the holes were drilled at 40° off horizontal and pointed toward the discharge. The DDD applied excessive forward motion especially to the larger particles. It appeared that lower fluidization velocities might be possible with the DDD if desired, but additional test work would be required to determine a more optimum angle of attack. Carrier stated that a DDD would be more expensive.

Because of the problems with the DDD, a straight through perforated deck (STPD) was installed. The STPD was fabricated out of about 28 gauge stainless steel with approximately 0.025" holes on 0.112" centers. This deck was designed for light duty service.

Fluidization of the coal was not difficult but nearly 12 ft/s velocity was required to maintained a well fluidized bed. When the bed was well fluidized, the larger particle moved through the bed with no problem even with the STPD.

The underflow/overflow system of coal discharge operated very well. The underflow draw point had to be modified to handle the larger particles. At marginal fluidization velocities, the underflow removed the larger and heavier particles as expected. At higher fluidization velocities, the effect is reduced because of better mixing in the bed but by limiting the underflow rate some segregation is still possible.

Fines production was very comparable to the Colstrip rates. The effect of expanded vs non-expanded freeboard was not tested this week. The unit as-operated was rigged for 100% expanded freeboard resulting in freeboard velocities of less than 8 ft/s. Further testing may indicate minimal fines increase with a non-expanded freeboard. Until data is available to indicate non-expanded is the correct approach, I recommend limiting freeboard velocities to less than 8 ft/s.

The inlet rotary airlock experienced pluggage similar to what we believe occurs at Colstrip and identical to what commonly occurred at the pilot plant in Butte.

The Carrier staff was very professional and competent. Their pilot facility is very impressive and is probably one of the finest in the country.

LIGNITE TESTING AT .RRIER 3/1/94 & 3/2/94

	Te .ing on 3/1/94			Testing on 3/2/94	
Test Run	1	2	3	4	5
In-feed - lb/m	12.3	12.4	18.9	27.0	22.5
Estimated Coal Residence Time - min	11.8	11.8	7.7	5.4	6.4
Overflow Discharge Rate -lb/m	est 6.4	6.4	10.7	13.4	9.0
Underflow Discharge Rate - lb/m	est 1.6	1.6	1.7	3.7	5.1
Fines Carry-over Rate - lb/m	est 0.8	0.8	est 1.0	1.9	2.0
Percent Fines (% infeed)	est 6.5	6.5	5.3	7.0	8.9
Gas in Temp - F	500	520	600	600	600
Gas out Temp - F	250	245	247	254	255
Gas Flow Rate - lb/m	47	47	53.9	62.7	59.6
Superficial Velocity ft/s	8.5	8.5	9.9	11.8	11.2
Coal out Temp - F	251	263	258	273	256
Overflow % Moisture	12.0	9.5	11.9	10.7	13.5
Underflow % Moisture	20.9	19.4	18.5	15.5	12.9
Overall Course Coal Outlet % Moisture	13.8	11.5	12.8	11.7	13.2
Fines % Moisture	na	na	na	15.7	na
In-feed % Moisture	na	na	na	38.2	38.1
Heat Supplied by Gas - BTU/m	5170	5687	8372	9979	9458
Heat Used by Coal	4181	4625	7043	10,302	8217
Heat Percent Closure	81	81	84	103	87
MMBTU/ton in first stage	0.84	0.92	0.88	0.74	0.84

Notes: Control during Test Run 4 was superior and the data most reliable.
Test Run 5 had in-bed heat exchange tubes present with 250 psig saturated steam inside the tubes.

BLACK & VEATCH

MEMORANDUM

Rosebud SynCoal
Center SynCoal
Carrier Vibrating
Equipment - Fluidization
Testing - Trip Report

B&V Project 24465.200
B&V File 15.0000
March 4, 1994

Fluidization testing performed on Tuesday, March 1, 1994 and Wednesday, March 2, 1994.

Recorded by: Bob Reymond

Tuesday, March 1, 1994
I met Jim Kinder of Carrier and Art Viall of Western SynCoal for breakfast. After breakfast, we went to Carrier's plant and took a tour of their laboratory. Their laboratory was extensive and quite capable of performing the testing which we required.

As they were setting up for our first test, we were shown a video of some fluidization testing which they had performed earlier. The testing was done using ambient air since their heaters were burned up and with the in-bed heat exchangers installed. The video showed that the lignite did not fluidize well due to what appeared to be air channeling up the vertical tubes.

Their test rig had two zones in the bed which was divided by a plate in between which started 3 inches below the top surface of the fluidized bed and extended upward. This forced the material to undergo some amount of plug flow. This also allowed them to adjust the airflow between the two sections differently using two controllable dampers in the supply ducts. The material was introduced into zone 1 from the hopper via a screw conveyor, a rotary valve, and a spinning distributor. The material flowed from zone 1 into zone 2 and out either the underflow or the overflow. Cameras were mounted which showed the front windows and a top window. The top camera was not much good because the glass plate condensed steam which caused the fines to adhere to the window and block the view.

Their test rig was a pretty fair approximation of the setup in the syncoal process. The only real modification they had to do was to put a duct from the outlet of their discharge fan back to the inlet of their supply fan. Carrier can adjust air flows, air temperature, and feed rates as well as the deck design. They measure temperatures and pressures throughout the rig. The control equipment measures air flow but it was not calibrated correctly so measurements using a magnahelic gage were taken from a pitot tube mounted in the ductwork. Some of the pressure gages were also out of operation and were measured using U-tubes.

Jim Kinder of Carrier performed the tests. The first test we performed used a laser drilled deck with the holes oriented 40° from horizontal which gave it a strong directional orientation. We found that this deck moved the large un-fluidized particles through the bed too quickly so that zone 2 had a larger average particle size than zone 1.

After the first test, Charlie Dryer from Omni-tech, the KC rep for Carrier, arrived. He stayed for the remaining tests.

The second test used a non-directional deck which worked much better. The particle size was even throughout and the underflow discharge was getting rid of the large particles. A problem with their test rig became apparent in that the underflow is off to one side and only about 3"x1.5". This caused large particles to build up in one corner and the bed temperature would begin to rise. Once it hit 300°F, the temperature would rise quickly as the lignite began to react. Jim Kinder and Brian Trudel agreed they would alter the rig overnight to increase the underflow size to fix this problem.

One of the results we found the first day was that the moisture content can be better predicted from the product discharge temperature than from the residence time.

Wednesday, March 2, 1994

The first test went very well and we were able to reproduce the results of the earlier test. The modification to the underflow had the effect of getting the large particles out of the bed and preventing the slumping and high temperatures we saw before. We found that by running the inlet gas temperature at 650°F and controlling the feed rate to maintain a product outlet temperature of about 275°F, we could produce a moisture content of about 11%. The fluidization velocity was about 12.2 fps which is what Carrier predicted in their proposal.

After lunch, Brian Trudel took Art and I on a tour of their manufacturing facility. Their facility was quite good and was kept in very orderly shape. Of particular interest was a piece of equipment that Carrier has developed which they call a drum horse. It is a vibrating horizontal cylinder which conveys material along it's length while swirling the material from side to side. It is used to convey castings in sand to cool them. The reason this was of interest is that Carrier has applied for a patent on a derivative of this which utilizes a fixed (separately mounted from cylinder) tube heat exchanger inside to cool the material as it is conveyed. Art Viall expressed interest in this piece of equipment and told Brian Trudel that they were considering replacing their coolers at the Colstrip facility. Brian Trudel told Art that the first one was not in operation but that if they were interested in these coolers, Carrier could step up the development. Art was sure that Colstrip would be willing to test a pilot cooler at their plant.

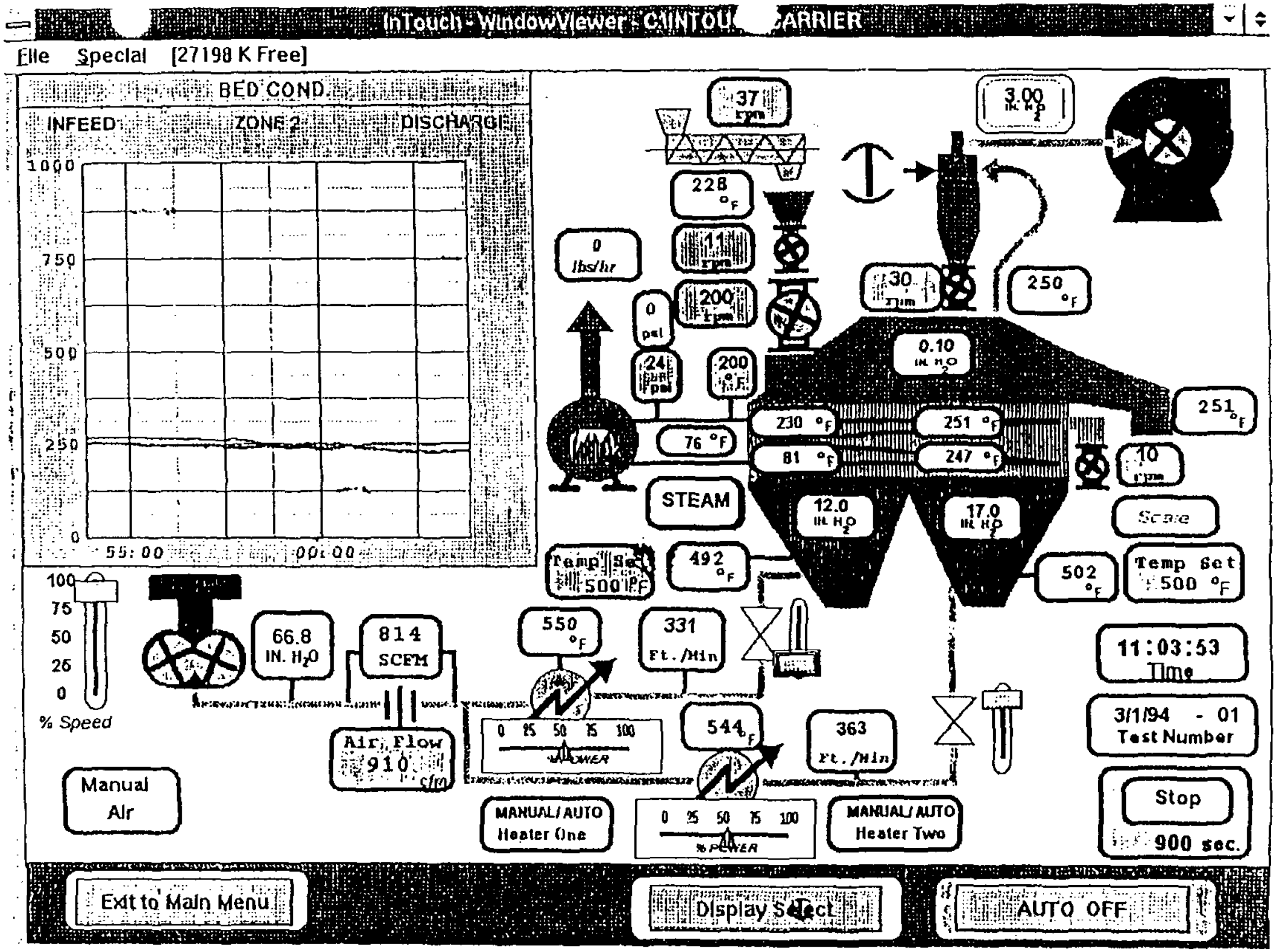
The second test was to calculate the U factor for the in-bed heat exchanger. Jim Kinder and Brian Trudel thought that it would not be good. The large particle size and resulting high fluidization velocity causes the air to channel up the tubes. This keeps the lignite from coming in contact with the tubes and transferring heat. The added obstructions also cause fluidization velocities to be higher. The results of the test indicated that the fan horsepower actually increased to fluidize the material (and this was fairly unstable. Carrier ran out of fan.) and got almost no heat transfer from the tubes.

Jim Kinder, Art and I had a number of discussions about how to test the second stage. The Carrier fans will not take 750°F gas and they can't just do a once through without starting a fire. Art had the idea to heat the supply gas with the electric heaters to 750°F and cool it back down to 250°F downstream of the bed with a desuperheater. We agreed this was the best option. Art also told them that the material coming out at 450°F needed to be put into drums and sealed as it came out to prevent it from burning.

All of the tests were videotaped and Carrier said they would send us a copy. Attached are the data printouts for each of the tests along with the data which was taken manually.

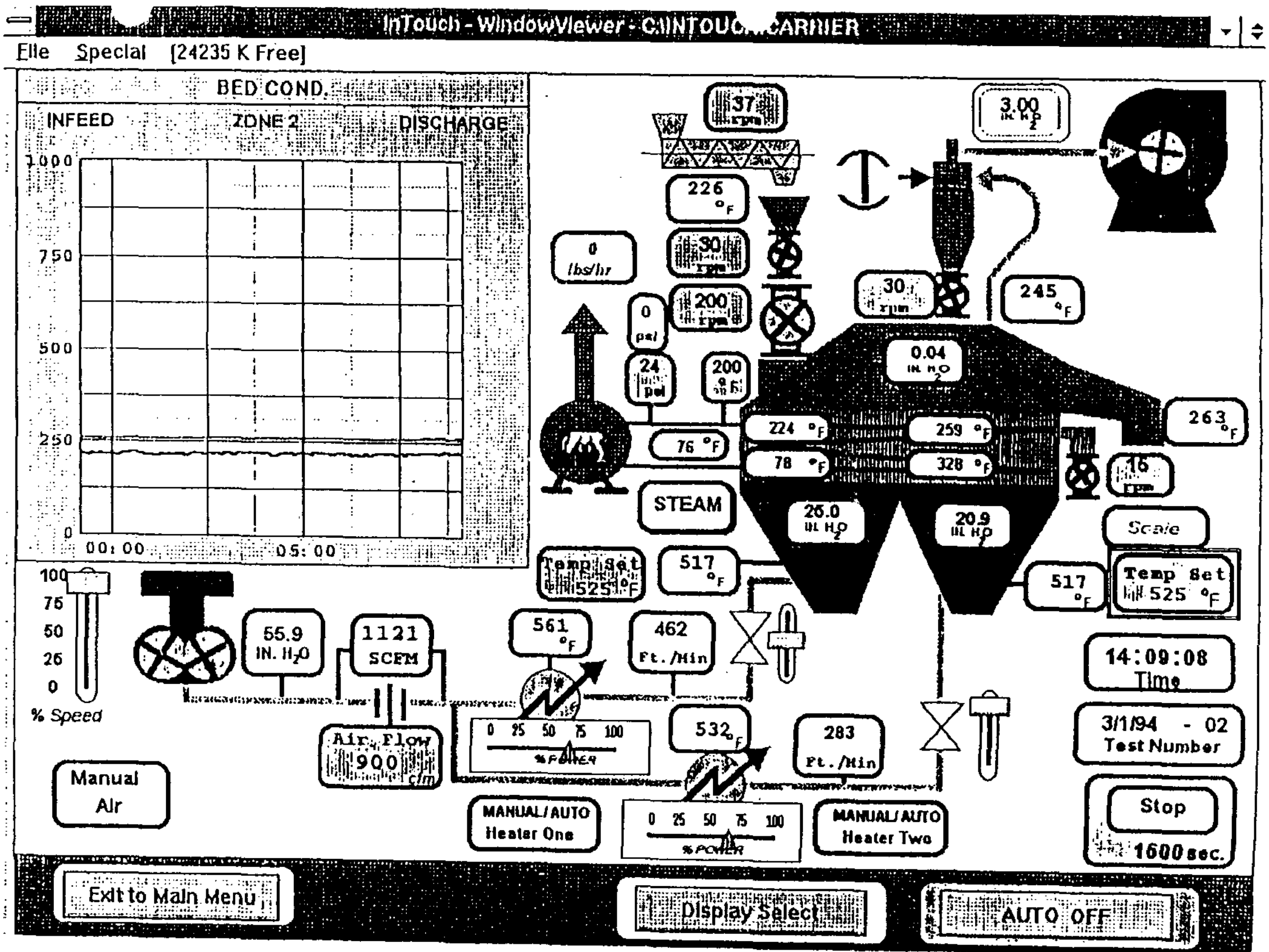
Distribution: Steve Wolf, NRG Energy, Inc.
Ray Sheldon, Western Syncoal
M. Bjeldanes
M. Perry
T. Phillips
B. Talley

G. Gunn



OTHER TEST DATA

40° FROM HORIZONTAL LASER DRILLED DECK



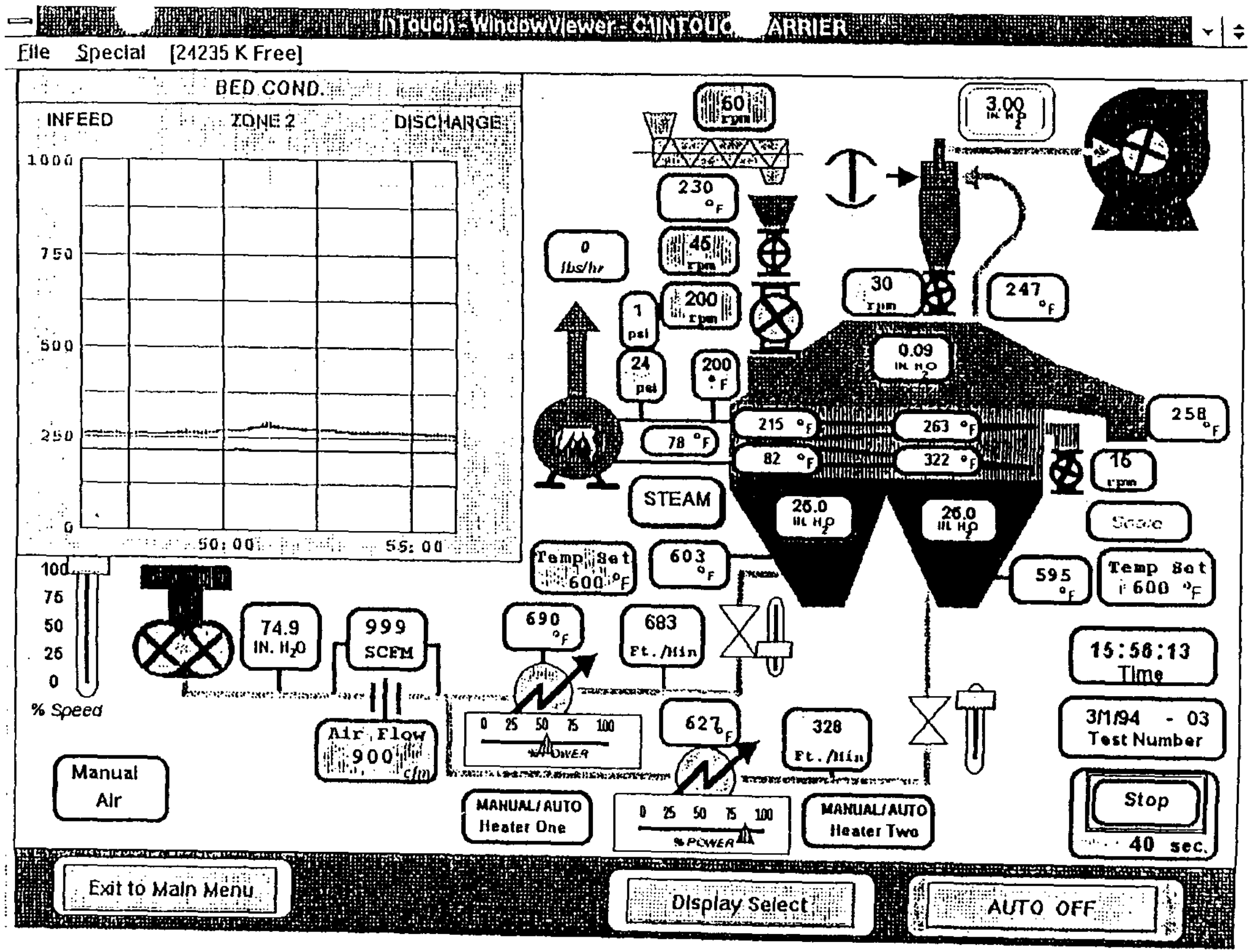
OTHER TEST DATA

STRAIGHT THROUGH DRILLED DECK

	FLOW RATE	MOISTURE
OVERFLOW DISCH	6.4 PPM	9.5%
UNDERFLOW DISCH	1.6 PPM	19.4%
FINES	0.8 PPM	—

AIRFLOW 1.5" @ 246°

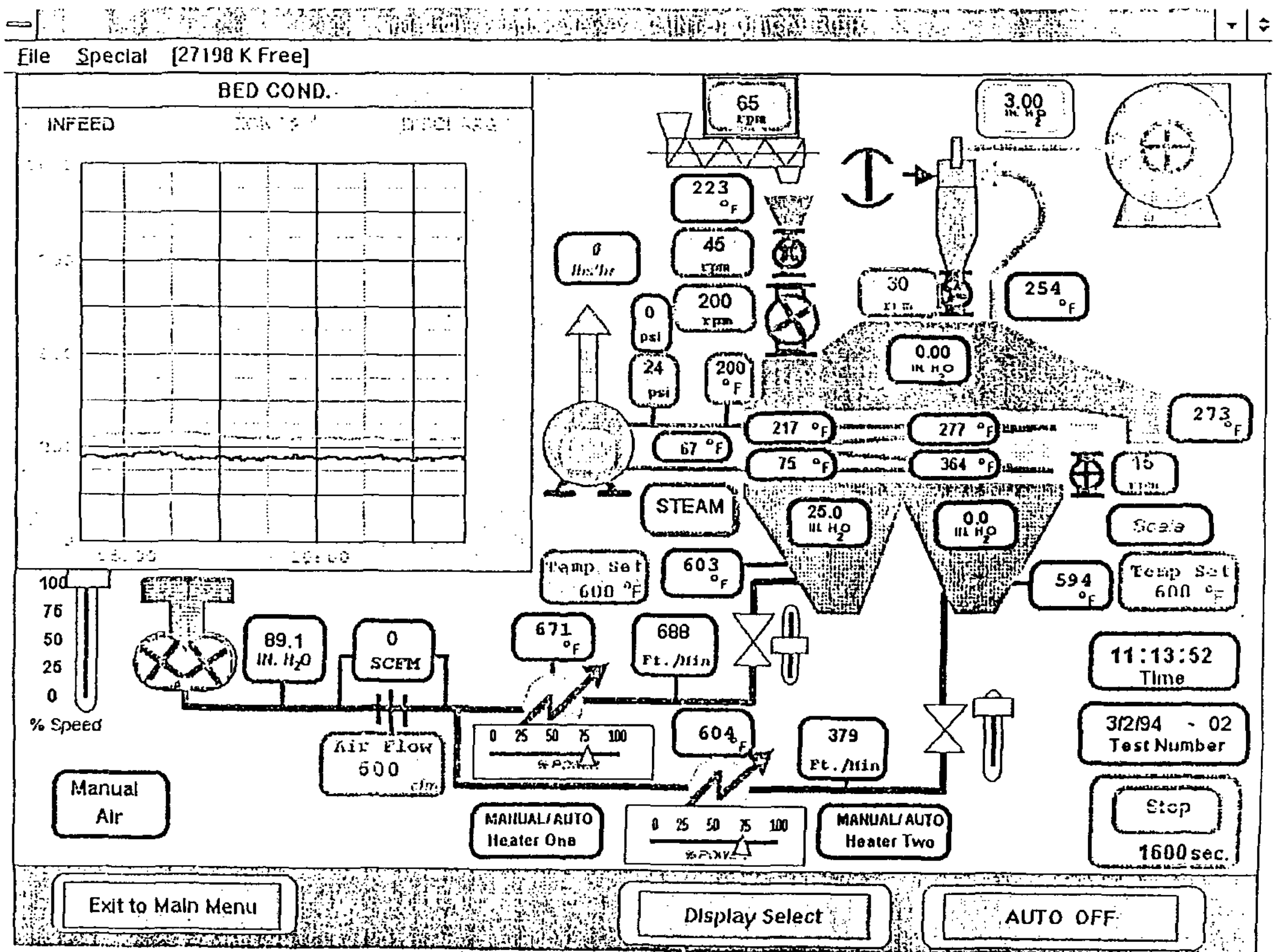
$ACFM = \sqrt{\Delta P / \rho}$



STRAIGHT DECK

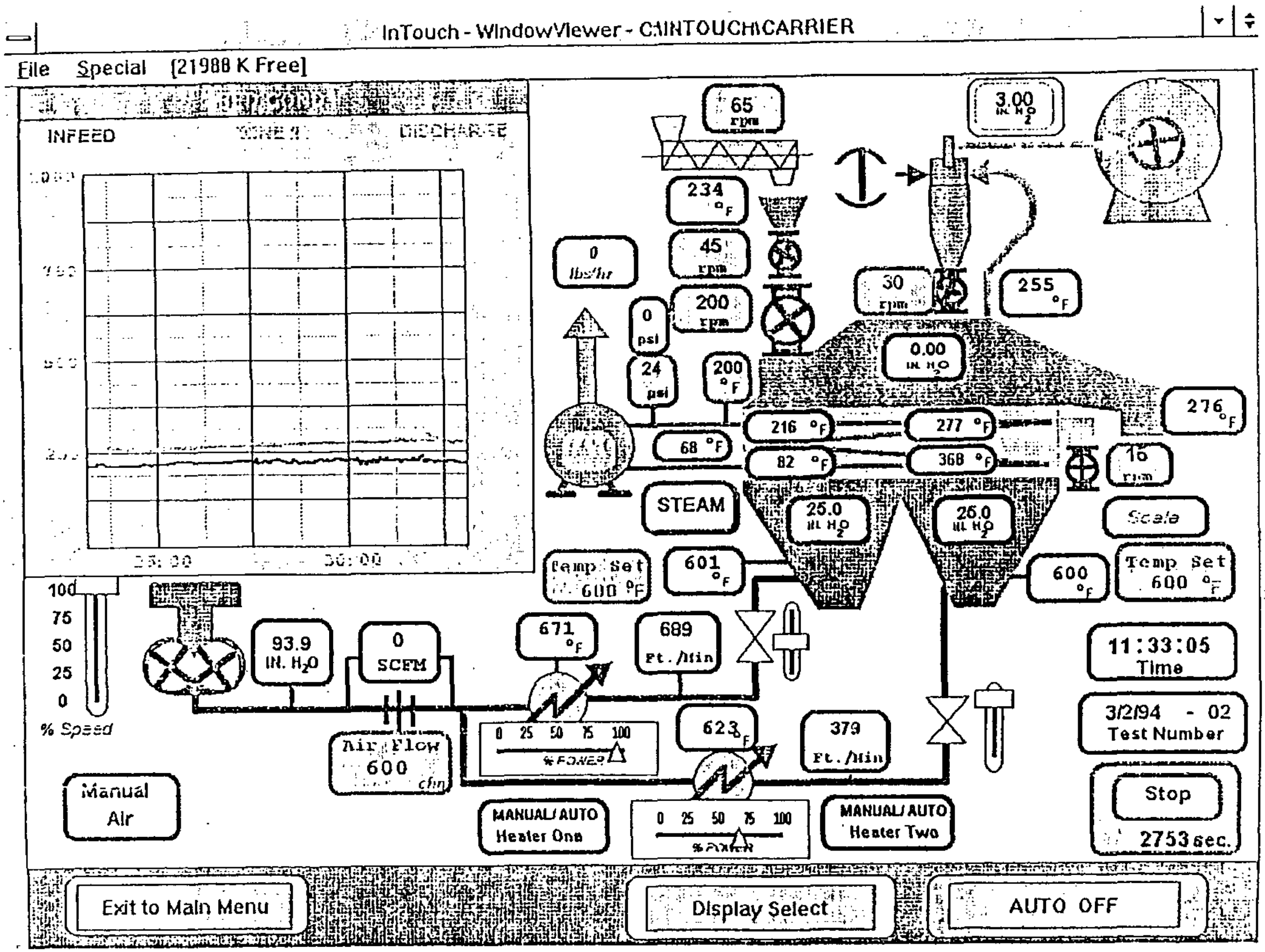
	FLOW	MOIST.
OVERFLOW DISCH	10.7 PPM	11.9%
UNDERFLOW DISCH	1.7 PPM	13.5%
FINES	NOT TAKEN	(15.5%?)

FLOW = 2.0" @ 250°F



OVERFLOW DISCH	13.4	10.7
UNDERFLOW DISCH	3.7	15.5
FINES	1.9	15.7
INFEED		38.2

DP = 2.8 in @ 260°F



WITH IN BED HEAT EXCHANGER

DP = 2.6" @ 280F

OVER	9.0 PPM	13.5%
UNDER	5.1 PPM	
FINES	2.0 PPM	

Carrier
Preliminary Report
Received 11/14/96

TEST REPORT

Rosebud Syncoal Project
File No. 96-CBO1-23-133-0
Test dates: 10/17/96 - 10/18/96

FILE COPY
PROJ. # 96-683
FILE # 4.5.1
COPY TO SDH
CBC
PWS

EQUIPMENT: Conventional Fluid Bed Dryer

MATERIAL: ~~¾" x 0"~~ pulverized lignite coal, bulk density = 40 pcf
Test 1/4" mat'l

PURPOSE

The ~~main~~ purpose of this test was to confirm the fines entrainment and to collect a fines sample in order to establish a particle size distribution.

PROCEDURE

- Dryer Test - Moisture reduction from approximately 36% to 12% was required. A 50 lb. batch of material was heated with from ambient to approximately 260 °F. The steam flow rate was 24.8 lb. per minute at 550 °F.
- Reactor Test - Using the remaining material from the dryer test, moisture reduction from 12% to less than 2% was required. Each sample was heated to 450 °F. The steam flow rate was 17 lb per minute at 750°F

TEST SET-UP

Steam for the test was provided by a 50 hp boiler, operating at approximately 100 psig. The flow of steam was primarily controlled by use of a globe valve, with fine tuning accomplished with a Roots blower. Flow velocity was measured with a Brandt air flow measuring station and a U-tube manometer. The steam was superheated by means of an electric heater.

bed depth?

The fluid bed model was a 12" x 12" bed with a 36" tall, 100% expanded hood. The perforated plate deck had 1/8" diameter holes on a 3/8" x 3/8" staggered pattern. Steam exiting the hood passed through a 12' long, 6" diameter duct. Test samples were taken from a 1" diameter port located at the mid-point of this duct. Fines were collected in a cyclone. The hood pressure was maintained between 0 and -1 in w.c. by means of an exhaust blower.

Carrier Vibrating Equipment

Rosebud Syncoal Fluid Bed Dryer Test

Results Summary

DRYER TESTS

Test No.	T-1	T-2	T-3	T-4	T-5
Sample Weight	50	50	50	50	50
Gas Flow, lbs/min	24.8	24.8	24.8	24.8	24.8
Gas Flow, in. w.c.	0.42*	1.4	1.4	1.4	1.4
Gas Temp., °F	550	550	550	550	550
Stack probe dia., in.	3/8	1/2	1/2	1/2	1/2
Final product temp., °F	275	260	260	260	260
Initial moisture, %	39.45	35.60	37.34	38.83	25.84
Final moisture, %	10.05	9.48	10.51	16.96	11.15

REACTOR TESTS

Test No.	T-6	T-7	T-8	T-9
Mat'l from Test No.	T-2	T-3	T-4	T-5
Sample Weight **	34.72	35.32	35.24	35.18
Gas Flow, lbs/min	17.0	17.0	17.0	17.0
Gas Flow, in. w.c.	0.63	0.63	0.63	0.63
Gas Temp., °F	750	750	750	750
Stack probe dia., in.	1/2	1/2	1/2	1/2
Final product temp., °F	450	450	450	450
Initial moisture, %	21.3	17.01	12.71	12.01
Final moisture, %	0.51	0.26	0.14	0.43

* 8" Brandt, all others measured on 6" Brandt

** Includes fines from dryer test

SIEVE ANALYSIS TEST REPORT
CARRIER VIBRATING EQUIPMENT

CUSTOMER: Rosebud Syncoal
MATERIAL: coal
TEST NO: fines from Reactor tests (cyclones)
FILE NO: 96-cb01-23-133-0
PROJ ENGR. JDK
DATE 10/21/96

Mesh No	Tare Wt (grams)	Total Wt (grams)	Net Wt (grams)	% Retain	% Cumulative	% Passing
.5inc	288.82	288.82	0.00	0.00	0.00	100.00
3.5	262.47	262.47	0.00	0.00	0.00	100.00
8	228.73	228.75	0.02	0.01	0.01	99.99
16	218.19	218.94	0.75	0.30	0.31	99.69
30	195.33	203.32	7.99	3.25	3.56	96.44
50	182.30	250.93	68.63	27.88	31.44	68.56
100	163.21	237.43	74.22	30.15	61.59	38.41
200	162.81	195.98	33.17	13.47	75.06	24.94
0	211.28	272.66	61.38	24.94	100.00	0.00

MATERIAL SAMPLE WEIGHT (grams)	246.32
SUM OF NET WEIGHTS (grams)	246.16
MINUTES VIBRATED (mins)	10

NOTE: Mesh No. 0 is the bottom pan

SIEVE ANALYSIS TEST REPORT
CARRIER VIBRATING EQUIPMENT

CUSTOMER: Rosebud Syncoal
MATERIAL: coal
TEST NO: final from stage 2 - product syncoal
FILE NO: 96-cb01-23-133-0
PROJ ENGR. JDK
DATE 10/21/96

Mesh No	Tare Wt (grams)	Total Wt (grams)	Net Wt (grams)	% Retain	% Cumulative	% Passing
.5inc	288.82	293.50	4.68	1.96	1.96	98.04
3.5	262.47	311.49	49.02	20.56	22.52	77.48
8	228.73	336.98	108.25	45.40	67.92	32.08
16	218.19	275.22	57.03	23.92	91.84	8.16
30	195.33	212.24	16.91	7.09	98.93	1.07
50	182.30	183.94	1.64	0.69	99.62	0.38
100	163.21	163.55	0.34	0.14	99.76	0.24
200	162.81	163.07	0.26	0.11	99.87	0.13
0	211.28	211.59	0.31	0.13	100.00	0.00

MATERIAL SAMPLE WEIGHT (grams)	238.6
SUM OF NET WEIGHTS (grams)	238.44
MINUTES VIBRATED (mins)	10

NOTE: Mesh No. 0 is the bottom pan

SIEVE ANALYSIS TEST REPORT
CARRIER VIBRATING EQUIPMENT

CUSTOMER: Rosebud Syncoal
MATERIAL: coal
TEST NO: t1 (fines from Stage #1)
FILE NO: 96-cb01-23-133-0
PROJ ENGR. JDK
DATE 10/21/96

Mesh No	Tare Wt (grams)	Total Wt (grams)	Net Wt (grams)	% Retain	% Cumulative	% Passing
.5inc	288.82	292.22	3.40	1.50	1.50	98.50
3.5	262.47	333.24	70.77	31.15	32.65	67.35
8	228.73	324.10	95.37	41.98	74.63	25.37
16	218.19	256.82	38.63	17.01	91.64	8.36
30	195.33	209.90	14.57	6.41	98.05	1.95
50	182.30	184.54	2.24	0.99	99.04	0.96
100	163.21	163.98	0.77	0.34	99.38	0.62
200	162.81	163.38	0.57	0.25	99.63	0.37
0	211.28	212.12	0.84	0.37	100.00	0.00

MATERIAL SAMPLE WEIGHT (grams)	227.33
SUM OF NET WEIGHTS (grams)	227.16
MINUTES VIBRATED (mins)	10

NOTE: Mesh No. 0 is the bottom pan

SIEVE ANALYSIS TEST REPORT
CARRIER VIBRATING EQUIPMENT

CUSTOMER: Rosebud Syncoal
MATERIAL: coal
TEST NO: 1/4 as rec. (pre- screened)
FILE NO: 96-cb01-23-133-0
PROJ ENGR. JDK
DATE 10/21/96

Mesh No	Tare Wt (grams)	Total Wt (grams)	Net Wt (grams)	% Retain	% Cumulative	% Passing
.5inc	288.82	288.82	0.00	0.00	0.00	100.00
3.5	262.47	265.60	3.13	0.97	0.97	99.03
8	228.73	348.50	119.77	37.07	38.04	61.96
16	218.19	313.60	95.41	29.53	67.57	32.43
30	195.33	246.31	50.98	15.78	83.34	16.66
50	182.30	210.60	28.30	8.76	92.10	7.90
100	163.21	177.77	14.56	4.51	96.61	3.39
200	162.81	169.72	6.91	2.14	98.75	1.25
0	211.28	215.33	4.05	1.25	100.00	0.00

MATERIAL SAMPLE WEIGHT (grams)	323.25
SUM OF NET WEIGHTS (grams)	323.11
MINUTES VIBRATED (mins)	10

NOTE: Mesh No. 0 is the bottom pan

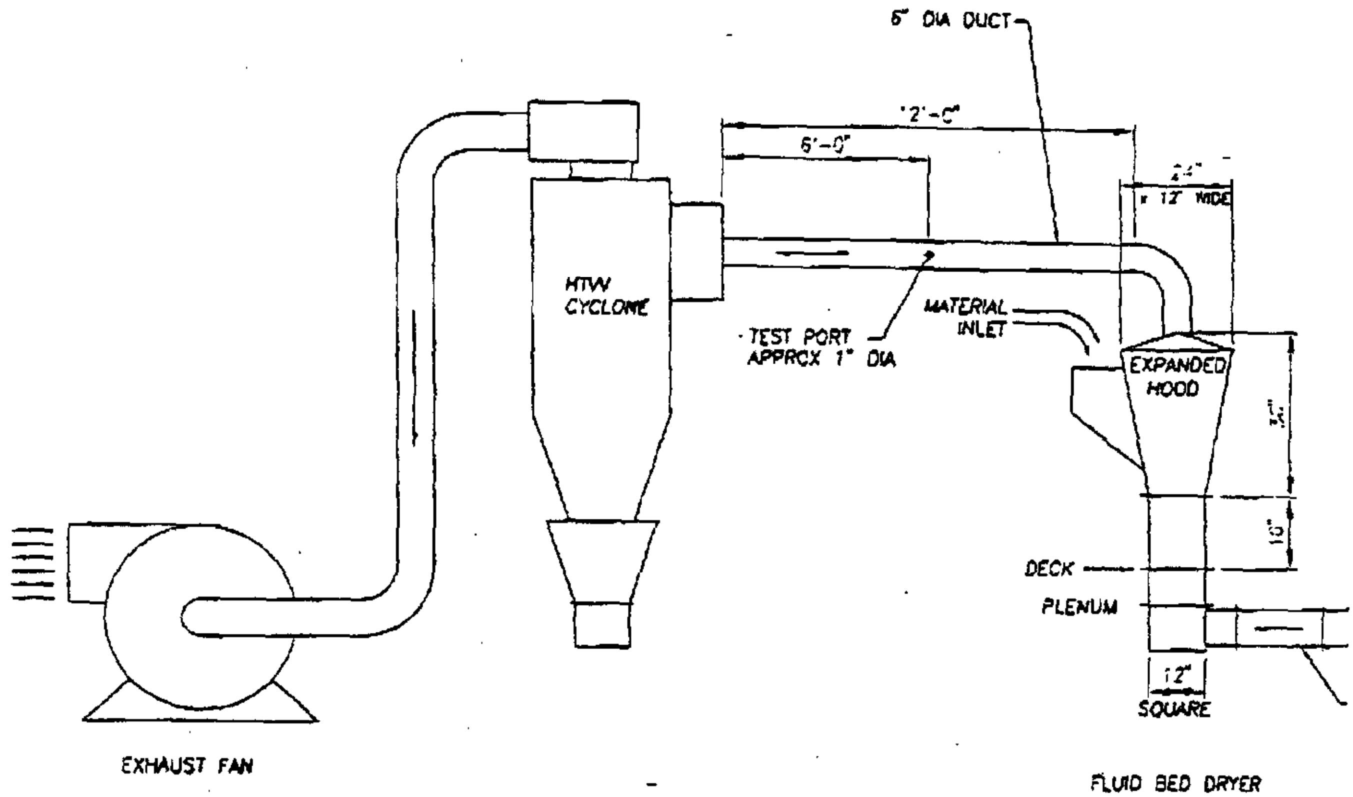
SIEVE ANALYSIS TEST REPORT
CARRIER VIBRATING EQUIPMENT

CUSTOMER: Rosebud Syncoal
MATERIAL: coal
TEST NO: 3/4 as rec ← screened from 1½" coal / 2" coal – may have all fines from crusher.
FILE NO: 96-cb01-23-133-0
PROJ ENGR. JDK
DATE 10/21/96

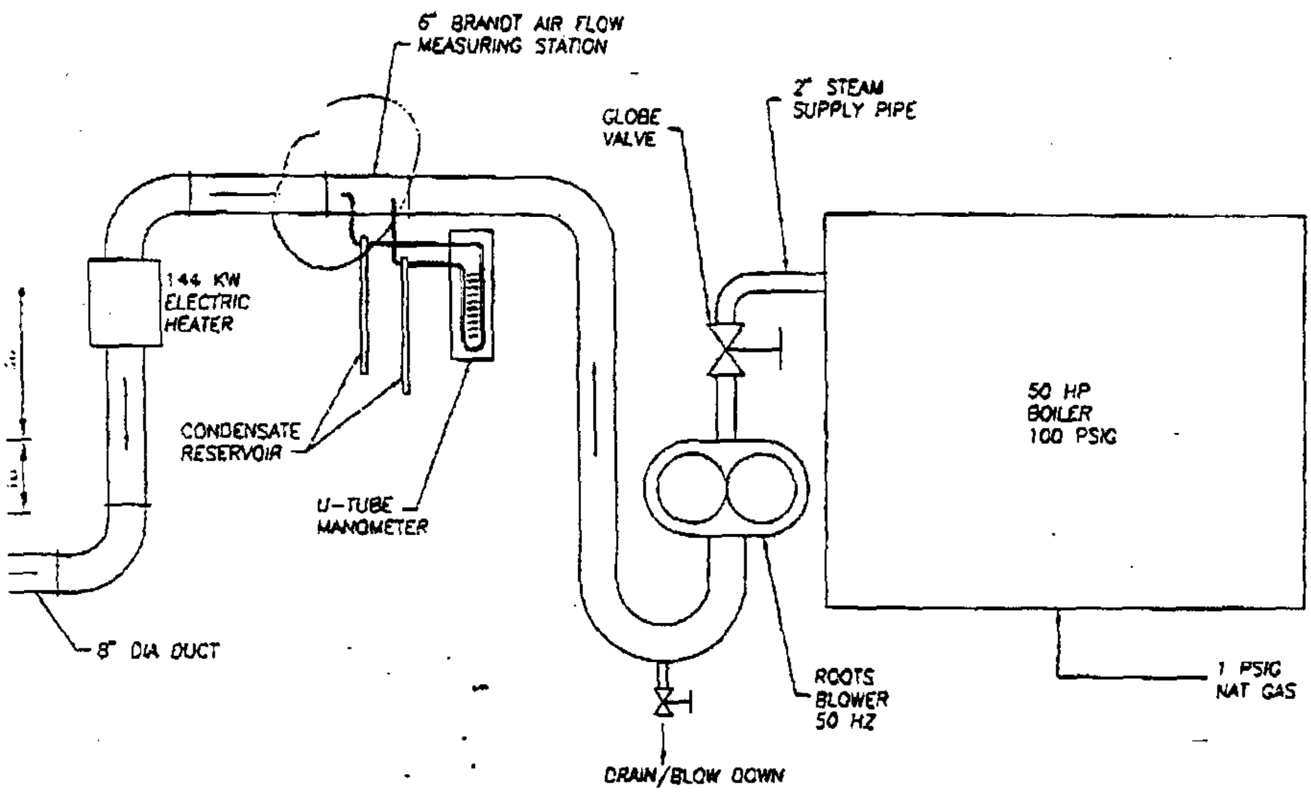
Mesh No	Tare Wt (grams)	Total Wt (grams)	Net Wt (grams)	% Retain	% Cumulative	% Passing
.5inc	288.82	354.12	65.30	23.90	23.90	76.10
3.5	262.47	436.60	174.13	63.73	87.63	12.37
8	228.73	256.64	27.91	10.21	97.84	2.16
16	218.19	219.77	1.58	0.58	98.42	1.58
30	195.33	195.92	0.59	0.22	98.63	1.37
50	182.30	182.99	0.69	0.25	98.89	1.11
100	163.21	164.61	1.40	0.51	99.40	0.60
200	162.81	163.87	1.06	0.39	99.79	0.21
0	211.28	211.86	0.58	0.21	100.00	0.00

MATERIAL SAMPLE WEIGHT (grams)	273.28
SUM OF NET WEIGHTS (grams)	273.24
MINUTES VIBRATED (mins)	10

NOTE: Mesh No. 0 is the bottom pan



NOTE: ALL HOT SURFACES INSULATED WITH APPROXIMATELY 2" OF MINERAL WOOL



CUSTOMER ROSEBUD/SYNCOAL CENTER, N.C.	DR. PCK	Carrier. Vibrating Equipment, Inc. Louisville, Kentucky 40233
	DATE 11/7/95	
	CK.	
	PE. JCK	
PURCHASE ORDER / FILE NUMBER	SCALE	
	DWG.NO. ROSEBUD1	REV.

APPENDIX D-4

M. R. YOUNG STATION TEST DATA

Report On SynCoal Testing Performed February 7, 1996
February 19, 1996

Objective:
The intent of this test was threefold. First, it may be necessary to develop plans for a SynCoal facility to only supply Milton R. Young Station with SynCoal to be used strictly for fuel oil displacement. Due to economics of facility construction, this would require determining the minimum amount of SynCoal necessary to achieve the same results as fuel oil usage. Secondly, as it is perceived that there are other benefits to burning SynCoal, a verification of the October 9, 1995 test was desired. Thirdly, again due to economics, it was felt prudent to empty the SynCoal storage bins at this time to reduce carbon dioxide inerting costs.

Prior Work:

Testing performed on October 9, 1995 was very similar to this test.

Test Procedure:

The procedure was to route each of the six feed systems on the SynCoal test burn skid into an individual cyclone. In this manner, SynCoal could be simultaneously injected into six of the seven cyclones. If a cyclone with SynCoal feed capabilities had a visible slag deposit in it, this cyclone would be chosen to perform the minimum SynCoal determination. This cyclone would only have one SynCoal rotary feeder feeding at a nominal anticipated value of 3,000 lb/hr of SynCoal. For the remaining cyclones with SynCoal feed capabilities, both of the rotary feeders for a given feed system were to be operated with an anticipated SynCoal flowrate of 6,000 LB/hr per feed system. This would result in an anticipated total boiler SynCoal flowrate of 33,000 LB/hr. Immediately prior to SynCoal being injected into the boiler, the one cyclone that did not have a feed system connected to it would be place in manual operation. SynCoal would then be introduced and the combustion controls allowed to adjust cyclone air and fuel flows on the six cyclones with SynCoal injections. Data would then be taken to monitor the operation of the boiler while under SynCoal injection. Visual observations would be made of the cyclone chosen for the minimum SynCoal flow portion of the test to ascertain slag condition.

Testing:

Prior to the start of the test, the cyclones were burning fair to good. No fuel oil was being burned. There was a small slag build-up in the front (burner end) of cyclone #'s 1,4,5,6, and 7. As the slag in cyclone #1 was very visible, it was chosen as the cyclone for the minimum SynCoal flow portion. The anticipated SynCoal flowrates were 6,000 lb/hr into Cyclone #'s 2, 3, 4, 5, and 6 with 3,000 lb/hr into cyclone #1. As cyclone #7 is not connected to the test skid, there was no SynCoal injected into cyclone #7.

When the test began the feed system flowrates were somewhat erratic. After considerable hammering on the bins, the blower pressures stabilized and remained so throughout the test. This recognizes that the blower pressure on the number 6 feed system, which was injecting into cyclone #1, increased when the second feeder was placed in service. SynCoal injection began at approximately 11:05. At approximately 11:30, the slag deposits in cyclone #'s 4, 5, and

6 were gone. The slag accumulation in cyclone #1 was about half of the original size. The slag accumulation in cyclone #7 was unchanged. At about 13:00, the slag accumulation in cyclone #1 was gone. At this point, the second feeder was started on the number 6 feed system such that cyclone #1 now had the same nominal SynCoal f ' as the other five with SynCoal injection. At about 13:30 the slag accumulation in cyclone #7 was gone. By 1..00, the slag accumulation in cyclone #7 had returned and was back to the original size and shape observed at the start of the test. As an objective was to empty the bins, the last 45 minutes of operation were somewhat erratic. The end of the test is therefore considered to be 15:30 with the system being secured at 16:15. The calculated flowrates achieved are as per the following table. The values in parentheses for the number 6 feed system reflect the one rotary feeder equipment lineup. Unfortunately, none of the feed systems operated at their nominal value. The best any feed system achieved was 80% of nominal which was the number 2 feed system.

Feed System	Cyclone Supplied	No-load Line Pressure Psig	Full-Load Line Pressure Psig	SynCoal Flowrate lb/hr
1	2	2.1	4.5	3,600
2	3	1.8	5.0	4,800
3	5	2.0	5.0	4,500
4	4	2.2	4.5	3,450
5	6	2.0	4.5	3,750
6	1	2.2	4.5 (3.8)	3,450 (2,400)
			Total	23,550 (22,500)

From the above blower pressures, for a 4.5 hour test, the total SynCoal fired would have been about 52 tons at an initial SynCoal flowrate of 11.25 ton/hr and a final flowrate of 11.78 ton/hr. This was surprising. It was estimated that after the October 9, 1995 test, there was approximately 25 tons of SynCoal remaining in the bins. After this apparent discrepancy was noted, additional calculations were performed using two approaches using the amount of d: -laced lignite as a basis. One method resulted in 42 total tons of SynCoal being fired with the other method y. ing 40 tons of SynCoal being fired. It is felt that the cold weather impacted the blower pressure gauges such that the 52 ton figure is high and the 40-42 ton figure is more accurate. Throughout the test, the HHV of the lignite being fired appeared to decrease. The fuel fired during the test appeared to be a 'fair' to 'marginal' fuel for cyclone combustion. This evaluation is based on the following observations. The cyclone fires appeared even and relatively stable but somewhat dark even with the SynCoal injection. A slag deposit in cyclone #7 disappeared but then reappeared as the test proceeded. Whereas the slagging in cyclone #7 had not progressed to the point where co-firing of oil was necessary, prolonged operation on the fuel quality being fired would have probably required oil later. The data collection proceeded without incident.

The following graphs are attached. All data is versus time.

Lignite feeder flows
Boiler gas temperatures
Boiler air heater outlet gas temperature
Generator gross output
Estimated lignite HHV
Boiler fuel moisture input
Boiler attemporator valve position
Boiler FD and ID motor current

Result Analysis:

s test was very difficult to analyze. The expected change in the boiler parameters appeared to occur during the first hour of the test and possibly into the second hour. The boiler parameters for the remainder of the test did not change as anticipated. The most plausible theory is that the lignite HHV began dropping drastically after hour ending 12:00. This is apparent from the test data. The unit gross load was relatively steady as was steam flow and turbine terminal temperatures. This indicates that the total heat supplied to the turbine cycle was relatively constant.

The lignite flowrate, however, was at 358,960 LB/hr at hour ending 10:00 and 384,240 LB/hr at hour ending 19:00. By reconciling the lignite flowrate, the SynCoal flowrate, and the relative heating values of both fuels against a fixed boiler heat duty, an estimate of the lignite HHV on an hourly basis can be calculated. This is demonstrated by the attached graph 'Estimated Lignite HHV During 2/7/1996 SynCoal testing'. Initially at the beginning of the test, the HHV of the lignite appeared to be approximately 6,650 Btu/Lb. From the hour ending 12:00 to the end of the test, the apparent lignite heating value steadily declined to an approximate value of 6,450 Btu/Lb. At hour ending 19:00, after the conclusion of the test, the apparent lignite heating value had further declined to less than 6,300 Btu/lb.

From other work with fuel ultimate analyses, in this range of HHV's the predominate varying factor is moisture. Much of the benefit of SynCoal injection to depressing gas temperatures and reducing the loading on the ID fans is due to the decrease in total gas mass flow caused by the lower SynCoal moisture content. Therefore, if the fuel quality decreased, and this decrease was due to higher fuel moisture content, the benefit that SynCoal would have normally produced from an overall boiler standpoint would have been negated by the higher fuel moisture. An attempt was made to calculate the total moisture introduced into the boiler on an hourly basis. This is illustrated on attached graph 'Total Boiler Fuel Moisture During 2/7/1996 Unit 1 SynCoal Testing'. This indicates that for the first hour of the test, hour ending 12:00, the total moisture decreased substantially. The boiler parameters responded ghly as expected. The following table illustrates this in comparison to the values achieved during the October 9, 95 test.

Parameter	10/9/95 Test Value	2/7/96 First Hour Test Value
Air Heater Exit Air Temperature-Deg F.	-10	+2
Air Heater Exit Gas Temperature-Deg F.	-8	-3
PSH Exit Gas Temperature-Deg F.	-30	-6
Lignite Flow-LB/Hr	-40,000	-32,000
SSH Attemporator Total Flow-Lb/Hr	-25,330	slight increase
RHSH Attemporator Flow-Lb/Hr	7,060	increased

In addition to these parameters, up to hour ending 12:00, the ID fan motor current appeared to decrease approximately 5 amperes per fan. From hour ending 13:00 to the end of the test, virtually all of the boiler parameters changed in the opposite direction from expected.

The objective of ascertaining the minimum SynCoal flowrate for cyclone slag removal appears to have been determined. The 2,400 lb/hr figure was successful in removing the slag deposit in cyclone #1 in approximately 120 minutes and preventing its reoccurrence. Based on what was seen while the test was in progress, this rate was maintained until hour ending 13:00 at which time the second feeder was started. The reason for the second feeder start was that during the test, it was felt that the capabilities of a 2,400 lb/hr feedrate had been demonstrated. Unfortunately, after the test data was reduced and the decrease in the fuel HHV was identified, there is now some (tion in the writer's minds if the 2,400 lb/hr rate would be effective in all cases. When the fuel quality decreased, the slag did not re-appear in cyclone #1 but at that point, SynCoal was being fed at a 3,450 lb/hr rate. The remaining cyclones that had SynCoal injected at a higher rate from the start of the test had their slag deposits removed in approximately 30 minutes.

Conclusions:

It has been demonstrated by previous testing that there is a dual benefit to co-firing SynCoal. The first is that SynCoal has the ability to remove slag deposits in the cyclone by increasing the heat input in the 'cold' area of the cyclone near the burner. The second is that it has the ability to depress the boiler gas temperatures through lower convection pass gas flowrates and what appears to be higher cyclone heat absorption. This test appears to have identified that the quantities of SynCoal necessary to achieve each benefit vary widely. From a slag removal standpoint, all testing, including this test, indicates that SynCoal can reliably remove slag deposits at an injection rate of between 2,400 to 4,800 lb/hr per cyclone.

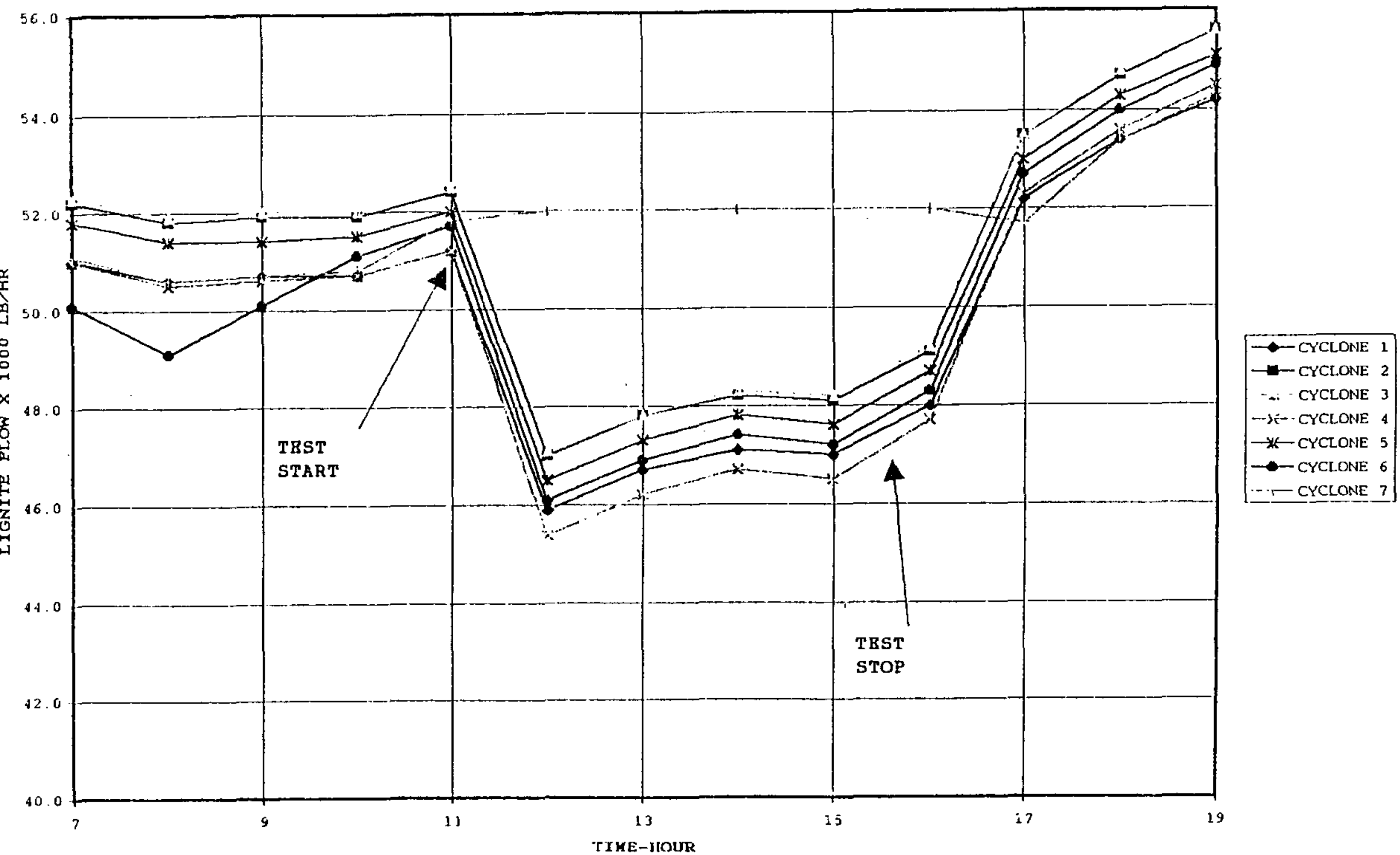
The quantity of SynCoal required to achieve the second benefit appears to vary widely and appears to be determined by the quality of the lignite being fired. During the October 9, 1995 test, apparently the lignite quality was such that the 25,300 lb/hr SynCoal injection rate effectively did reduce gas temperatures. During this test, with the steady decrease in lignite quality, the SynCoal injection rate of 23,550 lb/hr did not depress the gas temperatures. One would think reasonably that if SynCoal had not been injected, the boiler gas temperatures would have been higher than observed. However, if the goal would be to depress the boiler gas temperatures to a given value, for all qualities of lignite encountered, substantially more SynCoal would be required. The fuel quality fired during this test was nitely a fuel with slagging tendencies. However, it was not the 'worst' fuel that the unit has historically been fired with. This adds additional uncertainty to the SynCoal quantity required to control gas temperatures with any lignite quality encountered.

It appears that the unit is subject to relatively quick, relatively substantial swings in lignite quality. The long-term boiler operation would seem to consist of periods when the fuel quality is stable and periods when it is varying rapidly with different lignite HHV's. It would seem to be very difficult to reliably test for a given operating condition as there appears to be no way to accurately forecast when a particular condition is going to occur. It appears that the only practical way to thoroughly test the benefits of using SynCoal is to embark on some type of long-term test program. By this method, it would seem that the majority of operating scenarios can be evaluated with SynCoal injection. It may be determined that if a modest amount of SynCoal is fired continuously for cyclone slagging control, this improvement in cyclone combustion may reduce the need for higher SynCoal injection rates to depress boiler gas temperatures. Further evaluation of the data from this test and any subsequent test(s) will also be a continuing activity.

Dick Schwalbe
Dick Schwalbe

Roger Gazur
Roger Gazur

UNIT 1 LIGNITE FEEDER FLOWS DURING 2/7/1996 SYNCOAL TESTING



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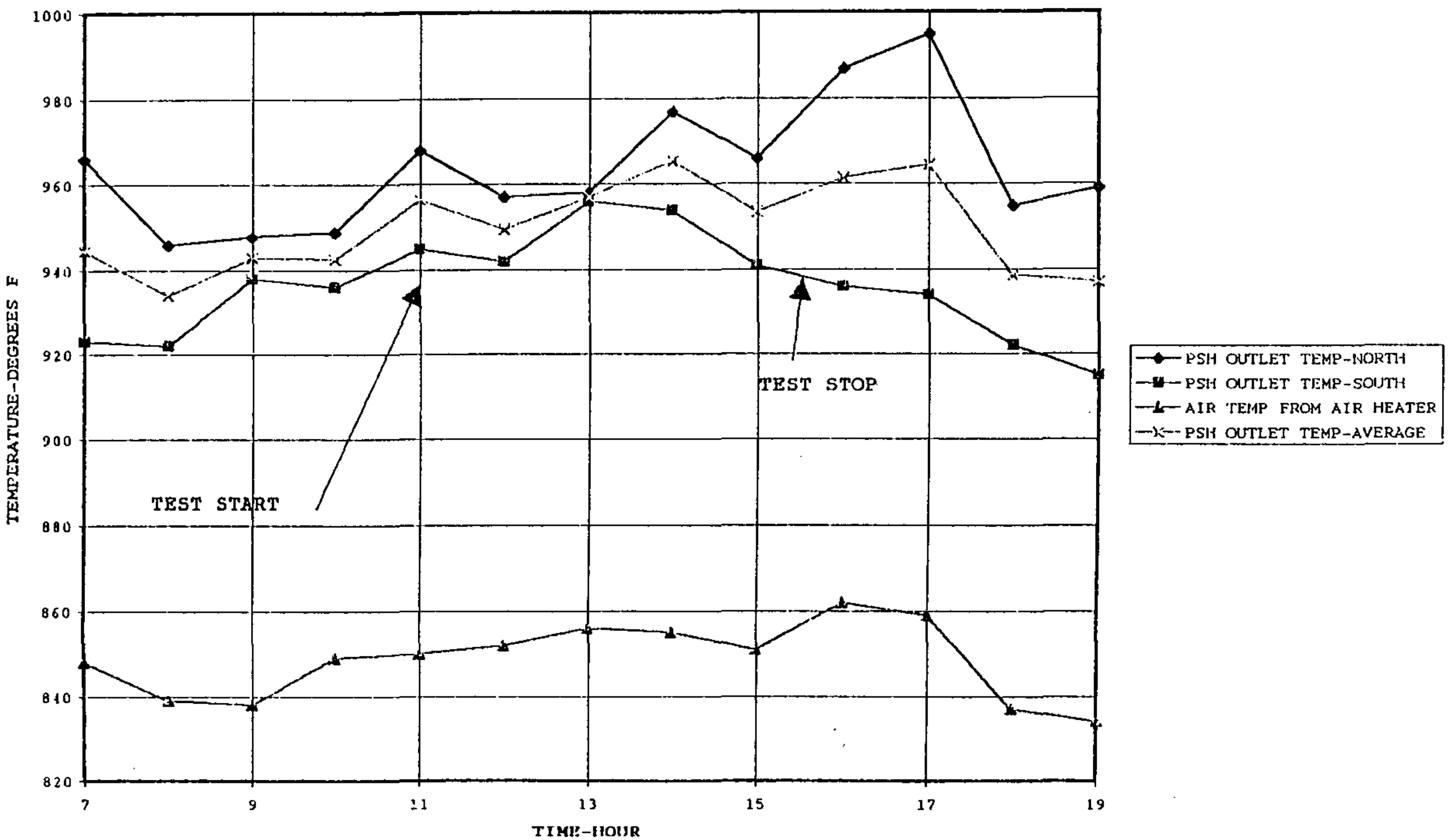
UNIT 1 BOILER GAS TEMPERATURES DURING 2/7/1996 SYNCOAL TESTING



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APPENDIX D-5

BLACK AND VEATCH IMPACT STUDY

APPENDIX D-5

BLACK AND VEATCH IMPACT STUDY

ROSEBUD SYNCOAL PARTNERSHIP
MILTON R. YOUNG POWER STATION

CENTER SYNCOAL PLANT IMPACT STUDY

B&V FILE NO. 24465.41.0800

ISSUE DATE AND REVISION NO.
041594-B

BLACK & VEATCH

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Contents (Continued)
Tables (Continued)

Figures

Center SynCoal Plant Impact Study

1.0 Introduction

Rosebud SynCoal Partnership has proposed a Lignite Drying Facility to be located on the site of the Milton R. Young Power Station. The Lignite Drying Facility will consist of two drying trains with an input capacity of 100 t/h each. The drying facility will produce approximately 65 t/h of dried SynCoal per train.

The Lignite Drying Facility will produce SynCoal which can be burned in the existing two steam generators at the Milton R. Young Power Station. The drying process will produce SynCoal with reduced moisture and sulfur content as well as increased specific heat content compared to the lignite currently burned in Units 1 and 2.

The purpose of this study is to evaluate the effects of burning SynCoal in the existing two steam generators. This study will also evaluate the impacts on overall plant performance from supplying drying steam from the existing steam generators. In addition, impacts of the Lignite Drying Facility on plant operations such as fuel handling, emissions, auxiliary power, bottom/fly ash production, and plant reliability will be addressed.

2.0 Requirements and Assumptions

The purpose of this study is to evaluate the effects on the Milton R. Young Power Station when providing process steam to the Lignite Drying Facility and the effects of burning the dried SynCoal product in the existing steam generators. In order to make these determinations, four assumed cases were evaluated and compared to a base case.

Case A is based upon all of the SynCoal produced at the drying facility being sold and shipped offsite. The only effect on the steam cycles would be caused by supplying process steam to be utilized by the drying facility. Case A is further divided into Case A1 and Case A2. Unit 1 provides all of the process steam in Case A1, while Unit 2 provides all of the process steam in Case A2.

Case B is based upon 30 t/h of the SynCoal product being burned onsite. Case B is further divided into Case B1 and Case B2. In Case B1, Unit 1 burns 30 t/h of SynCoal but Unit 2 provides the process steam to the drying facility. The case in which Unit 2 burns 30 t/h, was not analyzed or addressed in this study. Since it is anticipated Unit 2 will have depressed steam temperatures even after the addition of the tube surface modifications, the combustion of SynCoal in Unit 2 would not be advantageous.

All these cases are compared to a base case to evaluate the incremental effect each of these changes will have on the present operation of Units 1 and 2. The base case was modeled using the heat balances and operating data provided by the Milton R. Young Power Station personnel.

3.0 Summary and Conclusions

This study evaluates a total of five operating scenarios for the two existing units at the Milton R. Young Power Station. Improvements in performance were found in Case B1 for Unit 1 when Unit 1 burns 30 t/h of SynCoal, and in Case A2 for Unit 2 in which Unit 2 provides the process steam. This is especially encouraging since these cases can be operated simultaneously. Tables 3-1 and 3-2 include summaries of plant performance for each operating scenario.

The performance of Unit 1 is improved by burning SynCoal because of the higher Btu content and increase in boiler efficiency. The use of SynCoal will probably improve the flow of the slag in the cyclones as indicated by test burns; however, this effect cannot be quantified without more extensive test burns.

Unit 2 currently operates at the valves-wide-open condition with depressed steam temperatures. Since steam flow to the turbine cannot be increased, the only way to improve total generator output is to raise steam temperatures or to reduce turbine extraction. By removing extra process steam from the steam drum, main steam and reheat temperatures can be elevated, assuming the increase in heat input to the boiler is acceptable.

The major modification to the existing plant for the Lignite Drying Facility will be the installation of the process steam supply to the steam drum. Major modifications to the existing fuel handling system have been evaluated as impractical, necessitating the addition of a completely separate fuel handling system for the drying facility. Additional plant modifications, such as condensate, secondary air, boiler control, and ash handling, are addressed in more detail; however, no major modifications to the existing plant should be required. The capacity demands on these systems will not increase appreciably and in most cases will be reduced.

Table 3-1
Unit 1 Performance Summary

Operating Parameter	Base Case	Case A1	Case B1
Power Generation			
Net Turbine Output, MW	247	247	247
Auxiliary Power, MW	16.4	17.7	16.4
Net Plant Output, MW	230.6	229.3	230.6
Efficiency			
Boiler Efficiency, percent	82.1	81.7	84.0
Net Turbine Heat Rate, Btu/kWh	8,305	9,075	8,325
Net Plant Heat Rate, Btu/kWh	10,835	11,965	10,615
NPHR Charged to Power, Btu/kWh	–	10,845	–
Coal Rate, t/h	167.6	175.2	150.0
Coal Rate, lb/kW	1.45	1.53	1.30
Steam Conditions			
Main Steam Temperature, °F	987	1,005	986
Main Steam Flow, lb/h	1,682,000	1,692,300	1,695,500
Reheat Steam Temperature, °F	995	1,005	983
Reheat Steam Flow, lb/h	1,510,200	1,504,500	1,522,100
Flue Gas Conditions			
Furnace Exit Temperature, °F	1,820	1,880	1,820
Primary Reheater Exit Temperature, °F	1,400	1,450	1,390
Primary Superheater Inlet Temperature, °F	1,290	1,335	1,275
Primary Superheater Outlet Temperature, °F	855	880	845
Recirculated Flue Gas Temperature, °F	345	350	325
Economizer Outlet Temperature, °F	560	575	555
Air Heater Outlet Temperature, °F	335	350	325
Mine Coal Balance			
Lignite to Unit 1, t/h	167.6	175.2	120.0
Lignite to Unit 2, t/h	320.2	320.2	337.9*
Lignite to Drying Facility, t/h	0	200	200
Total Lignite from Mine, t/h	487.8	695.4	657.9

*Assumes that Unit 2 is supplying the process steam and is performing as described in Case A2.

Table 3-2
Unit 2 Performance Summary

Operating Parameter	Base Case	Case A2
Power Generation		
Net Turbine Output, MW	481	483.1
Auxiliary Power, MW	33.9	33.9
Net Plant Output, MW	447.1	449.2
Efficiency		
Boiler Efficiency, percent	82.0	81.7
Net Turbine Heat Rate, Btu/kWh	7,780	8,280
Net Plant Heat Rate, Btu/kWh	10,205	10,900
NPHR Charged to Power, Btu/kWh	–	10,350
Coal Rate, t/h	320.2	337.9
Coal Rate, lb/kW	1.43	1.50
Steam Conditions		
Main Steam Temeprature, °F	985	1,005
Main Steam Flow, lb/h	3,271,000	3,271,900
Reheat Steam Temperature, °F	985	1,005
Reheat Steam Flow, lb/h	2,827,500	2,852,700
Flue Gas Conditions		
Furnace Exit Temperature, °F	1,735	1,755
Final Reheater Inlet Temperature, °F	1,600	1,620
Primary Reheater Exit Temperature, °F	1,325	1,350
Primary Superheater Outlet Temperature, °F	980	995
Air Heater Inlet Temperature, °F	825	835
AH First Pass Outlet Temperature, °F	610	620
Economizer 1 Outlet Temperature, °F	505	505
Air Heater Outlet Temperature, °F	340	350
Mine Coal Balance		
Lignite to Unit 1, t/h	167.6	167.6
Lignite to Unit 2, t/h	320.2	337.9
Lignite to Drying Facility, t/h	200	200
Total Lignite from Mine, t/h	687.8	705.5

4.0 Environmental and Licensing Requirements

An assessment was performed to determine if the addition of the proposed Lignite Drying Facility to the Milton R. Young Power Station (Facility) would trigger any additional air emissions and impact requirements. It is expected that the addition of the Lignite Drying Facility will only result in an increase in particulate matter emissions. Therefore, only particulate matter emissions were considered for this analysis. However, the change in stack sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from the Units 1 and 2 stacks will be presented and discussed.

The addition of the coal dryer and associated conveying equipment is predicted to increase the current base case particulate emissions at the existing Milton R. Young Power Station by approximately 14.56 tons per year. This potential increase results from the additional transfer points and conveyor belts used to transfer lignite to the new dryer and back to the main conveyor belts.

If the emissions increase associated with the proposed modification is greater than the state and federal "significant net emissions increases," then the proposed modification would be subject to Prevention of Significant Deterioration (PSD) review including analyses, such as an ambient air quality impact assessment and a Best Available Control Technology (BACT) assessment. The State of North Dakota's "significant net emission increase" criteria level of 15 tons per year of Particulate Matter less than 10 microns in diameter (PM_{10}) and 25 ton per year criteria level for Particulate Matter (PM) is given in Chapter 33-15-15-01 of the North Dakota Air Pollution Regulations (NDAPR). For this regulatory analysis, it was conservatively assumed that all PM emitted as a result of the proposed modification will be PM_{10} (i.e., assume PM = PM_{10}). Because the potential change in PM emissions is below the state and federal significant emission increase level of 15 tons per year of PM_{10}, the proposed construction will not be subject to PSD review. However, the Milton R. Young Power Station is required to apply for and receive a North Dakota Department of Health (NDDH) air permit to construct in accordance with NDAPR Chapter 33-15-14-02 and demonstrate that the net PM/PM_{10} emission increases associated with the proposed modification are below the defined PSD significance criteria.

Even though the estimated PM/PM_{10} emission rates are predicted to be less than the PSD significance criteria, the Milton R. Young Power Station will still be required to meet New Source Performance Standards (NSPS) for the new pneumatic coal cleaning equipment and conveyor(s). NSPS for particulate matter require opacity limits of 10 and 20 percent, respectively, for these new sources.

The following sections will address two key issues. The first issue is the applicability of NSPS. NSPS were adopted by the 1970 Clean Air Act and later amended in the 1977 revision to the Act. North Dakota has adopted the Federal NSPS (40 CFR 60) as Chapter 33-15-12 of the NDAPR. The second issue is the need to apply for and receive a permit to construct from NDDH.

4.1 NSPS Applicability

NSPSs apply to new or modified stationary sources that increase the amount of any air pollutant emitted into the atmosphere or results in the emission of any air pollutant not previously emitted.

Large electric utility steam generating plants are regulated in NSPS under Subparts Da and Db. However, these standards apply only to the steam generating unit. No provisions are made in Subparts Da or Db for material/fuel handling at the plant.

Subpart Y of the NSPS regulates coal preparation plants. A "coal preparation plant" is defined in the regulation as "any facility (excluding underground mining operations) which prepares coal by one or more of the following processes: breaking, crushing, screening, wet or dry cleaning, and thermal drying." Subpart Y is applicable to the following "affected facilities" in coal preparation plants which process more than 200 tons per day of coal:

- Thermal dryers.
- Pneumatic coal cleaning equipment.
- Coal processing and conveying equipment (including breakers, crushers, screens, and conveyor belts).
- Coal storage systems (any facility used to store coal except open storage piles).
- Coal transfer and loading systems (any facility used to transfer and load coal for shipment).

The Milton R. Young Power Station is designated as a major stationary source. NSPSs apply to "any stationary source which contains an affected facility." An "affected facility" is defined, with reference to a stationary source, as "any apparatus to which a standard is applicable." Any distinct function performed by the stationary source, even if not its primary function, is considered when applying NSPS. Although the plant's primary function is to provide electric power, the functions performed by the proposed project will be coal drying and cleaning (i.e., preparation of coal).

NSPS Subpart Y limits the emission of particulate matter (PM) to the atmosphere for the following processes:

- Thermal dryers: gases shall not contain PM in excess of 0.070 g/dscm (0.031 gr/dscf) or exhibit 20 percent opacity or greater.
- Pneumatic coal cleaning equipment: gases shall not contain PM in excess of 0.040 g/dscm (0.018 gr/dscf) or exhibit 10 percent opacity or greater.
- Coal processing and conveying equipment, coal storage systems, or coal transfer and loading systems: gases shall not exhibit 20 percent opacity or greater.

Items two and three listed above are applicable to the proposed Milton R. Young Power Station modification. The first item which limits the PM concentration in exhaust gases does not apply because the coal dryer to be installed at the Milton R. Young Station does not meet the definition of "thermal dryer" in 40 CFR 60 Subpart Y or NDAPR Chapter 33-15-12-04.19. Specifically, the coal dryer will be processing lignite, not bituminous coal as specified in the definition of "thermal dryer" in the regulations. Therefore, NSPS requires that opacity (visual emissions) from the pneumatic coal cleaning equipment and conveyors, transfer systems, and unloading systems shall not exceed 10 and 20 percent, respectively. In addition, the exhaust gases from the pneumatic cleaning equipment shall not contain PM in excess of 0.018 gr/dscf.

4.2 New Permitting Requirements

NDAPR Chapter 33-15-14-02 requires that "No construction, installation, or establishment of a new stationary source . . . may be commenced unless the owner or operator thereof shall file an application for and receive, a permit to construct in accordance with this chapter." Since PM/PM_{10} emissions will increase as a result of the proposed modification, the regulation considers the proposed modification to be a "construction, installation, or establishment of a new source," and thus, a permit to construct must be obtained for the proposed modification. The NDDH may require the submittal of emissions estimates, plans, specifications, and an ambient air quality impact analysis.

NDAPR Chapter 33-15-15-04 sets the application requirements for obtaining a "major modification" to an existing major source. A modification is considered to be major if the modification results in a significant net emission increase. A significant net emission increase for PM is defined in NDAPR Chapter 33-15-15-01.1.(aa) as 15 tons per year or greater of PM_{10} or 25 tons per year of PM. Because it has been conservatively assumed that all PM to be emitted as a result of the proposed modification will be PM_{10}, the 15 tons per year threshold applies.

To determine if the project causes an increase in PM emissions in excess of these levels, a material handling emission study was performed.

PM emissions from material handling processes are difficult to quantify due to the variations in material, handling operations, and weather conditions. EPA recommends an estimation procedure using approved references such as the Compilation of Air Pollutant Emission Factors (AP-42). AP-42 was developed by EPA to estimate emissions from various combustion and material handling processes. AP-42 is used almost exclusively in this study to estimate uncontrolled emission factors.

Once these estimates are made, control efficiencies for different mitigation measures are assigned. Particulate control measures for the plant vary from the use of a wetting agent (50 percent control) to the use of an enclosure with fabric filter (99 percent control). AP-42 cites several studies to assign control efficiencies to the various control measures. One study used extensively for this analysis is the Workbook on Estimation of Emissions and Dispersion Modeling for Fugitive Particulate Sources, Environmental Research & Technology, Washington, D.C.; Document P-A857 September 1981.

4.3 Assumptions

The following assumptions were made for the lignite handling operations. The assumptions were incorporated into the attached spreadsheets:

- Annual lignite throughput is based on maximum design capacity estimates of 1,752,000 tons per year to the Lignite Drying Facility, which is equivalent to 200 tons per hour.
- Silt content of the coal before entering the Lignite Drying Facility is 1.18 percent conservatively estimated based on the percentage by weight of the lignite passing through the No. 50 sieve. Estimates of the silt content of the lignite product is 7.26 percent based on the percentage by weight of product passing through the 200 mesh sieve.
- The surface moisture content before entering the drying facility is 5 percent, while the surface moisture content after exiting the facility is one-half percent.

- The annual wind speed utilized for the site was taken from the closest National Weather Service Station, which is located in Bismarck, North Dakota.
- SynCoal product shipped offsite will utilize 18 ton, 26 wheel tandem-trucks with a 45 ton capacity. This analysis assumes a paved road of approximately one-quarter mile will be constructed for the trucks to ship the SynCoal product offsite. This roadway is assumed to have a standard industrial surface material silt content of 12.5 percent with a surface dust loading of 1,750 lb/mile.
- Control equipment, utilizing hoods, and fabric filter dust collectors with a 99.9 percent efficiency, will be present at all SynCoal drop locations. In addition, all screw and drag conveyors will be totally enclosed.
- SynCoal drop from the loadout bin to the tandem-trucks will utilize a telescopic chute along with a hood and fabric filter collector, providing a 75 percent dust control efficiency.
- For conservatism, this analysis assumes all particulate matter emitted at the site is less than 10 μm in diameter (PM_{10}).
- It was assumed the existing coal pile will be used to provide coal to the Lignite Drying Facility. Thus, an assessment of PM emissions from a new or larger existing coal pile was not conducted.
- The pneumatic coal handling system is considered to be a sealed system resulting in no PM emissions.

4.4 Particulate Matter Control Measures

Due to the potentially wide variation of control levels, several control assumptions were made. The following is a listing of assumptions for specific controls, their estimated control efficiency, and a brief description of the process. In every case, conservative estimates of control efficiency were used:

- Enclosure with Fabric Filter-99 (+) percent control. The use of a hood connected to a fabric filter system provides for one of the highest achievable control efficiencies.
- A telescopic chute, along with a hood and fabric filter, will provide a minimum of 75 percent control.

- Equipment located in the Lignite Drying Facility structure is totally enclosed by the structure. Therefore, all air vented from the building will pass through the fabric filter.
- Note: Refer to the spreadsheets for delineation of where each control technique is applied.

4.5 Material Handling Particulate Matter Emission Estimates

Table 4-1 summarizes the results of the estimated particulate matter emissions for the operating scenarios. Tables 4-2 and 4-2a and Tables 4-3 and 4-3a provide a listing of the input parameters for each potential source. Table 4-4 lists the applicable emission factors or equations used in estimating the particulate emissions.

The results listed in Table 4-1 indicate that the addition of the Lignite Drying Facility would increase the current base case particulate matter emissions by 14.56 tons per year with the worst case scenario. If a portion of the SynCoal product is used by Unit 1 or 2, the increase in materials handling particulate matter emissions will be 13.19 tons per year. All operation scenarios associated with proposed modification will result in PM emission increases less than 15 tons per year significant emissions increase level for PM_{10}. Thus, the proposed modification will not be considered a major modification subject to PSD reviews. However, the Milton R. Young Station will be required to obtain a state air permit for the proposed modification, and provide a materials handling analysis which demonstrates that PM emissions increases associated with the proposed modification will be less than 15 tons per year.

4.6 Further Consideration and Recommendations

Because this analysis was preliminary, additional assessments are recommended to confirm regulatory applicability. The recommended actions are discussed in the following paragraphs.

It is suggested that in addition to the AP-42 methodology used to develop the annual fugitive dust emission estimates for this analysis, that a quantification of particulate emissions be conducted based on mechanical exhauster outlet grain loading and flow rates. Even though the AP-42 method is acceptable in most states, the NDDH may not allow this method to be used to quantify fugitive PM/PM_{10} emissions. Consultation with the NDDH could confirm which method is appropriate in this situation.

Table 4-1
Comparison of Annual Particulate Emissions for Various Operating Scenarios

Operating Case	Particulate Matter Emissions (tons/year)
A	14.56
B	13.19

Table 4-2
Case A--All Products Sold Offsite Maximum Design Capacity
(Particulate Emission Assumptions for Material Handling Operations)

Facility and Site Parameters	
Maximum Annual Coal Throughput--Before Dryer, ton/year	1,752,000
Maximum Daily Coal Throughput--Before Dryer, ton/day	4,800
Maximum Annual Coal Throughput--After Dryer, ton/year	1,138,000
Maximum Annual Coal Throughput--After Dryer, ton/day	3,120
Maximum Annual Dryer Output of Coarse Coal, ton/year	876,000
Maximum Daily Dryer Output of Coarse Coal, ton/day	2,400
Maximum Annual Dryer Output of Fine Coal, ton/year	262,800
Maximum Daily Dryer Output of Fine Coal, ton/day	720
Coal Silt Content, s--Before Dryer, percent	1.18
Coal Surface Moisture, M--Before Dryer, percent	5
Coal Silt Content, s--After Dryer, percent	7.26
Coal Surface Moisture, M--After Dryer, percent	0.5
Bismarck, North Dakota Wind Speed, U (mean), mph	10.2
Number of Lanes, lanes	2
Surface Material Silt Content, percent	12.5
Surface Dust Loading, lb/mile	1,750
Average Vehicle Weight, tons	18.0

Table 4-2a
Case A--Annual Particulate Emissions from Material Handling Operations

No.	Source	Activity	AP-42 Equation	U	M	Emission Factor	Use Rate	Uncontrolled Emissions	Control Method	Control Effcy.	Total Controlled Emissions	Point Source Emissions	Area Source Emissions
1	Coal Pile Reclaim Hopper	Coal Drop From Reclaim Hopper to Under Coal Pile Belt Feeder	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Hood and Fabric Filter	99.9%	0.00 tons/yr	0.00 lb/hr	
2	Under Coal Pile Belt Feeder Conveyor	Coal Conveying	Conveying			0.0034 lb/t	1,703,000 tons/yr	2.90 tons/yr	Underground Conveyor	99.9%	0.00 tons/yr		0.00 lb/hr
3	Coal Transfer Under Coal Pile	Coal Drop From Belt Feeder to Reclaim Conveyor	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Hood and Fabric Filter	99.9%	0.00 tons/yr	0.00 lb/hr	
4	Reclaim Conveyor from Under Coal Pile	Coal Conveying - Reclaim Conveyor	Conveying			0.0034 lb/t	1,703,000 tons/yr	2.90 tons/yr	Underground Conveyor (Partial Cover above ground)	70.0%	0.88 tons/yr		0.20 lb/hr
5	Drying Facility Feed Conveyor	Coal Drop From Reclaim Conveyor to Drying Facility Feed Conveyor	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Hood and Fabric Filter	99.9%	0.00 tons/yr	0.00 lb/hr	
6	Drying Facility Feed Conveyor	Coal Conveying	Conveying			0.0034 lb/t	1,703,000 tons/yr	2.90 tons/yr	Total Enclosure	99.9%	0.00 tons/yr		0.00 lb/hr
7	Coal Crusher	Coal Drop From Drying Facility Feed Conveyor to Crusher	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Hood and Fabric Filter	99.9%	0.00 tons/yr	0.00 lb/hr	
8	Coal Crushing	Coal Crushing	Stone Crushing			0.2880 lb/t	1,703,000 tons/yr	245.28 tons/yr	Hood and Fabric Filter	99.9%	0.25 tons/yr	0.06 lb/hr	
9	Surge Hopper	Coal Drop From Coal Crusher to Surge Hopper	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Hood and Fabric Filter	99.9%	0.00 tons/yr	0.00 lb/hr	
10	Surge Hopper	Coal Drop From Surge Hopper to Belt Feeders	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Enclosure Plus Hoods and Fabric Filters	99.9%	0.00 tons/yr	0.00 lb/hr	
11	Belt Feeder	Coal Conveying	Conveying			0.0034 lb/t	1,703,000 tons/yr	2.90 tons/yr	Enclosure Plus Hoods and Fabric Filters	99.9%	0.00 tons/yr		0.00 lb/hr
12	Belt Feeder/Screw Conveyor Transfer Points	Coal Drop From Belt Feeders to Screw Conveyors	Drop	10	5	0.0017 lb/t	1,703,000 tons/yr	1.45 tons/yr	Hood and Fabric Filter	99.9%	0.00 tons/yr	0.00 lb/hr	
13	Screw Conveying Coal into Lignite Drying Facility	Coal Conveying	Conveying			0.0034 lb/t	1,703,000 tons/yr	2.90 tons/yr	Total Enclosure	99.9%	0.00 tons/yr		0.00 lb/hr
14	Lignite Drying Facility	Coal Conveying through First and Second Stage Fluid Bed Dryers and Immersion Drum Cooler for Coarse Coal	Pneumatic Handling			0.0000 lb/t	876,000 tons/yr	0.00 tons/yr	Sealed System	99.9%	0.00 tons/yr		0.00 lb/hr
15	Lignite Drying Facility	Coal Conveying through First and Second Stage Fluid Bed Dryers for Fine Coal	Pneumatic Handling			0.0000 lb/t	262,000 tons/yr	0.00 tons/yr	Sealed System	99.9%	0.00 tons/yr		0.00 lb/hr
16	Lignite Drying Facility	Coarse Coal Drop from Lignite Drying Conveyors to Vibrating Screen	Drop	10	0.5	0.0417 lb/t	876,000 tons/yr	18.26 tons/yr	Hood and Fabric Filter	99.9%	0.02 tons/yr	0.00 lb/hr	
17	Lignite Drying Facility Vibrating Screen	Coarse Coal Screening	Screening			0.1100 lb/t	876,000 tons/yr	48.18 tons/yr	Total Enclosure	99.9%	0.05 tons/yr		0.01 lb/hr
18	Lignite Drying Facility	Coarse Coal Drop from Vibrating Screen to Deep Bed Stratifiers	Drop	10	0.5	0.0417 lb/t	876,000 tons/yr	18.25 tons/yr	Hood and Fabric Filter	99.9%	0.02 tons/yr	0.00 lb/hr	
19	Lignite Drying Facility	Coarse Coal Drop from Deep Bed Stratifiers to Loadout Drag Conveyor	Drop	10	0.5	0.0417 lb/t	876,000 tons/yr	18.25 tons/yr	Total Enclosure	99.9%	0.02 tons/yr	0.00 lb/hr	
20	Lignite Drying Facility	Fine Coal Drop to Loadout Drag Conveyor	Drop	10	0.5	0.0417 lb/t	261,600 tons/yr	5.45 tons/yr	Total Enclosure	99.9%	0.01 tons/yr	0.00 lb/hr	
21	Loadout Drag Conveyor	Coal Conveying to Loadout Bin (Coarse and Fine Coal)	Conveying			0.0034 lb/t	1,138,800 tons/yr	1.94 tons/yr	Total Enclosure	99.9%	0.00 tons/yr		0.00 lb/hr
22	Loadout Facility	Coal Drop from Loadout Drag Conveyor to Loadout Bin	Drop	10	0.5	0.0417 lb/t	1,138,800 tons/yr	23.72 tons/yr	Hood and Fabric Filter	99.9%	0.02 tons/yr	0.01 lb/hr	
23	Loadout Bin	Coal Drop from Loadout Bin through Telescopic Chute to 45 Ton Loadout Truck	Drop	10	0.5	0.0417 lb/t	1,138,800 tons/yr	23.72 tons/yr	Telescopic Chute	75.0%	5.93 tons/yr	1.35 lb/hr	
24	Plant Roads	Trucks to Loadout Facility Transport Loadout Coal from Facility	Paved Roads Paved Roads			1.1600 lb/VMT 2.6381 lb/VMT	3,850 VMT/yr 3,850 VMT/yr	2.15 tons/yr 5.10 tons/yr		0.0% 0.0%	2.15 tons/yr 5.10 tons/yr	0.49 lb/hr 1.16 lb/hr	
							TOTAL =	435.486 tons/yr		TOTAL =	14.56 tons/yr		

Table 4-3
Case B--A Portion of the Product is Sold Offsite
and a Portion is Burned in Unit 1
(Particulate Emission Assumptions for Material Handling Operations)

Facility and Site Parameters	
Maximum Annual Coal Throughput--Before Dryer, ton/year	1,752,000
Maximum Daily Coal Throughput--Before Dryer, ton/day	4,800
Maximum Annual Coal Throughput--After Dryer, ton/year	1,138,000
Maximum Annual Coal Throughput--After Dryer, ton/day	3,120
Maximum Annual Dryer Output of Coarse Coal, ton/year	876,000
Maximum Daily Dryer Output of Coarse Coal, ton/day	2,400
Maximum Annual Dryer Output of Fine Coal, ton/year	262,800
Maximum Daily Dryer Output of Fine Coal, ton/day	720
Maximum Annual Output to Loadout Bin, ton/year	876,000
Maximum Daily Output to Loadout Bin, ton/day	2,400
Maximum Annual Output to Storage Silo, ton/year	262,800
Maximum Daily Output to Storage Silo, ton/day	720
Coal Silt Content, s (AP-42 mean)--Before Dryer, percent	1.18
Coal Surface Moisture, M (AP-42 mean)--Before Dryer, percent	5
Coal Silt Content, s (AP-42 mean)--After Dryer, percent	7.26
Coal Surface Moisture, M (AP-42 mean)--After Dryer, percent	0.5
Bismarck, North Dakota Wind Speed, U (mean), mph	10.2
Number of Lanes, lanes	2
Surface Material Silt Content, percent	12.5
Surface Dust Loading, lb/mile	1,750
Average Vehicle Weight, tons	18.0

Table 4-3a
Case B--Annual Particulate Emissions from Material Handling Operations

No.	Source	Activity	AP-42 Equation	U	M	Emission Factor	Use Rate	Uncontrolled Emissions	Control Method	Control Effcy.	Total Controlled Emissions	Point Source Emissions	Area Source Emissions
1	Coal Pile Reclaim Hopper	Coal Drop From Reclaim Hopper to Under Coal Pile Belt Feeder	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.46 ton/yr	Hood and Fabric Filter	99.6%	0.00 ton/yr	0.00 lb/h	
2	Under Coal Pile Belt Feeder Conveyor	Coal Conveying	Conveying			0.0034 lb/t	1,782,000 ton/yr	2.88 ton/yr	Underground Conveyor	99.9%	0.00 ton/yr		0.00 lb/h
3	Coal Transfer Under Coal Pile	Coal Drop From Belt Feeder to Reclaim Conveyor	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.46 ton/yr	Hood and Fabric Filter	99.9%	0.00 ton/yr	0.00 lb/h	
4	Reclaim Conveyor from Under Coal Pile	Coal Conveying - Reclaim Conveyor	Conveying			0.0034 lb/t	1,782,000 ton/yr	2.88 ton/yr	Underground Conveyor (Partial Enclosure above ground)	70.0%	0.88 ton/yr		0.20 lb/h
5	Drying Facility Feed Conveyor	Coal Drop From Reclaim Conveyor to Drying Facility Feed Conveyor	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.46 ton/yr	Hood and Fabric Filter	99.9%	0.00 ton/yr	0.00 lb/h	
6	Drying Facility Feed Conveyor	Coal Conveying	Conveying			0.0034 lb/t	1,782,000 ton/yr	2.88 ton/yr	Total Enclosure	99.9%	0.00 ton/yr		0.00 lb/h
7	Coal Crusher	Coal Drop From Drying Facility Feed Conveyor to Crusher	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.45 ton/yr	Hood and Fabric Filter	99.9%	0.00 ton/yr	0.00 lb/h	
8	Coal Crushing	Coal Crushing	Stone Crushing			0.2000 lb/t	1,782,000 ton/yr	248.38 ton/yr	Hood and Fabric Filter	99.9%	0.25 ton/yr	0.06 lb/h	
9	Surge Hopper	Coal Drop From Coal Crusher to Surge Hopper	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.46 ton/yr	Hood and Fabric Filter	99.9%	0.00 ton/yr	0.00 lb/h	
10	Surge Hopper	Coal Drop From Surge Hopper to Belt Feeders	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.45 ton/yr	Enclosures Plus Hoods and Fabric Filters	99.9%	0.00 ton/yr	0.00 lb/h	
11	Belt Feeder	Coal Conveying	Conveying			0.0034 lb/t	1,782,000 ton/yr	2.88 ton/yr	Enclosures Plus Hoods and Fabric Filters	99.9%	0.00 ton/yr		0.00 lb/h
12	Belt Feeder/Screw Conveyor Transfer Points	Coal Drop From Belt Feeders to Screw Conveyors	Drop	10	8	0.0017 lb/t	1,782,000 ton/yr	1.45 ton/yr	Hood and Fabric Filter	99.9%	0.00 ton/yr	0.00 lb/h	
13	Screw Conveying Coal Into Lignite Drying Facility	Coal Conveying	Conveying			0.0034 lb/t	1,782,000 ton/yr	2.90 ton/yr	Total Enclosure	99.9%	0.00 ton/yr		0.00 lb/h
14	Lignite Drying Facility	Coal Conveying through First and Second Stage Fluid Bed Dryers and Immersion Drum Cooler for Coarse Coal	Pneumatic Handling			0.0000 lb/t	870,000 ton/yr	0.00 ton/yr	Sealed System	99.9%	0.00 ton/yr		0.00 lb/h
15	Lignite Drying Facility	Coal Conveying through First and Second Stage Fluid Bed Dryers for Fine Coal	Pneumatic Handling			0.0000 lb/t	870,000 ton/yr	0.00 ton/yr	Sealed System	99.9%	0.00 ton/yr		0.00 lb/h
16	Lignite Drying Facility	Coarse Coal Drop From Lignite Drying Conveyors to Vibrating Screen	Drop	10	0.5	0.0417 lb/t	870,000 ton/yr	18.25 ton/yr	Hood and Fabric Filter	99.9%	0.02 ton/yr	0.00 lb/h	
17	Lignite Drying Facility Vibrating Screen	Coarse Coal Screening	Screening			0.1100 lb/t	870,000 ton/yr	71.18 ton/yr	Total Enclosure	99.9%	0.05 ton/yr		0.01 lb/h
18	Lignite Drying Facility	Coarse Coal Drop From Vibrating Screen to Deep Bed Stratifiers	Drop	10	0.5	0.0417 lb/t	870,000 ton/yr	13.38 ton/yr	Hood and Fabric Filter	99.9%	0.01 ton/yr	0.00 lb/h	
19	Lignite Drying Facility	Coarse Coal Drop from Deep Bed Stratifiers to Loadout Drag Conveyor	Drop	10	0.5	0.0417 lb/t	870,000 ton/yr	18.35 ton/yr	Total Enclosure	99.9%	0.02 ton/yr	0.00 lb/h	
20	Lignite Drying Facility	Fine Coal Drop to Loadout Drag Conveyor	Drop	10	0.5	0.0417 lb/t	283,000 ton/yr	5.47 ton/yr	Total Enclosure	99.9%	0.01 ton/yr	0.00 lb/h	
21	Loadout Drag Conveyor	Coal Conveying to Loadout Bin (Coarse and Fine Coal)	Conveying			0.0034 lb/t	870,000 ton/yr	1.48 ton/yr	Total Enclosure	99.9%	0.00 ton/yr		0.00 lb/h
22	Loadout Facility	Coal Drop From Loadout Drag Conveyor to Loadout Bin	Drop	10	0.5	0.0417 lb/t	870,000 ton/yr	18.28 ton/yr	Hood and Fabric Filter	99.9%	0.02 ton/yr	0.00 lb/h	
23	Loadout Bin	Coal Drop from Loadout Bin through Telescopic Chute to 45 Ton Loadout Truck	Drop	10	0.5	0.0417 lb/t	870,000 ton/yr	18.23 ton/yr	Telescopic Chute	75.0%	4.56 ton/yr	1.04 lb/h	
24	Drag Conveyor to Coal Storage Bin	Coal Conveying to Storage Bin (Coarse and Fine Coal)	Conveying			0.0034 lb/t	283,000 ton/yr	0.45 ton/yr	Total Enclosure	99.9%	0.00 ton/yr		0.00 lb/h
25	Coal Storage Bin	Coal Drop From Storage Drag Conveyor to Coal Storage Bin	Drop	10	0.5	0.0417 lb/t	283,000 ton/yr	5.47 ton/yr	Hood and Fabric Filter	99.9%	0.01 ton/yr	0.00 lb/h	
26	Plant Roads	Trucks to Loadout Facility	Paved Roads			1.3000 lb/VMT	3,650 VMT/yr	2.15 ton/yr		0.0%	2.15 ton/yr	0.43 lb/h	
		Transport Loadout Coal from Facility	Paved Roads			3.0101 lb/VMT	3,650 VMT/yr	5.10 ton/yr		0.0%	5.10 ton/yr	1.14 lb/h	
							TOTAL =	430.80 ton/yr		TOTAL =	13.10 ton/yr		

Also, the analysis assumed that any volatile organic compounds (VOCs) driven off from the coal in the drying process as well as any other pollutants, will be vented to the Unit 2 stack. Therefore, it is assumed that there will be no net emissions increase of any other pollutants, except PM/PM_{10}, as a result of the Lignite Drying Facility addition thereby resulting in no further PSD review.

The existing and proposed Facility roads are assumed to be paved. If the Facility will contain any unpaved roads, then a significant increase in PM/PM_{10} emissions will likely occur beyond the estimates indicated by this analysis. This could potentially cause the PM/PM_{10} emissions to exceed the 15 ton per year limit.

5.0 SynCoal Process

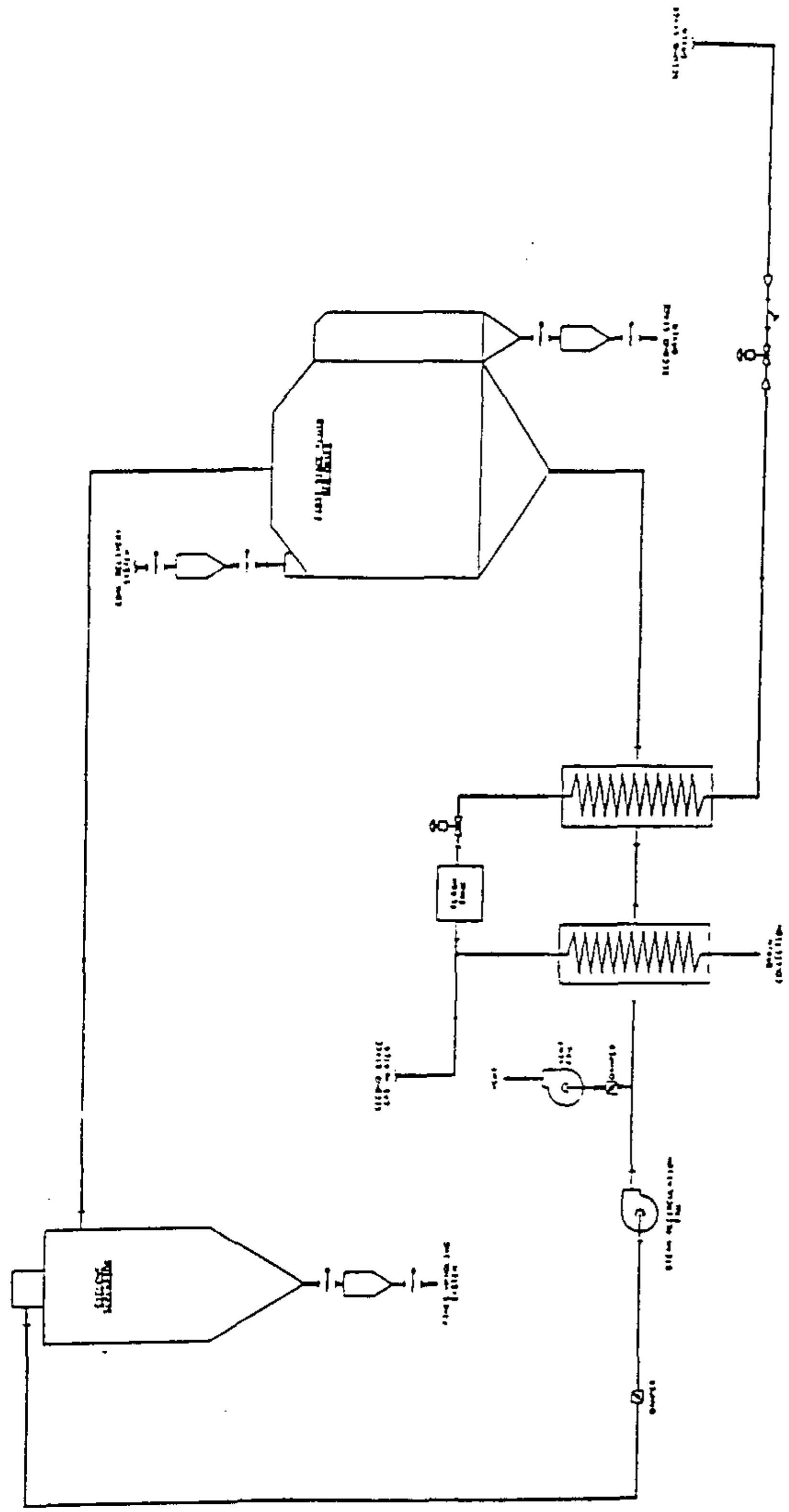
The SynCoal process consists of a lignite supply system, a first- and second-stage drying system, a product cooling system, a fines handling system, a condensate collection system, an auxiliary cooling system, a product cleaning system, and a product delivery system.

Lignite is delivered to the drying facility from the Unit 1 active storage pile. This system is detailed in Section 7.3.

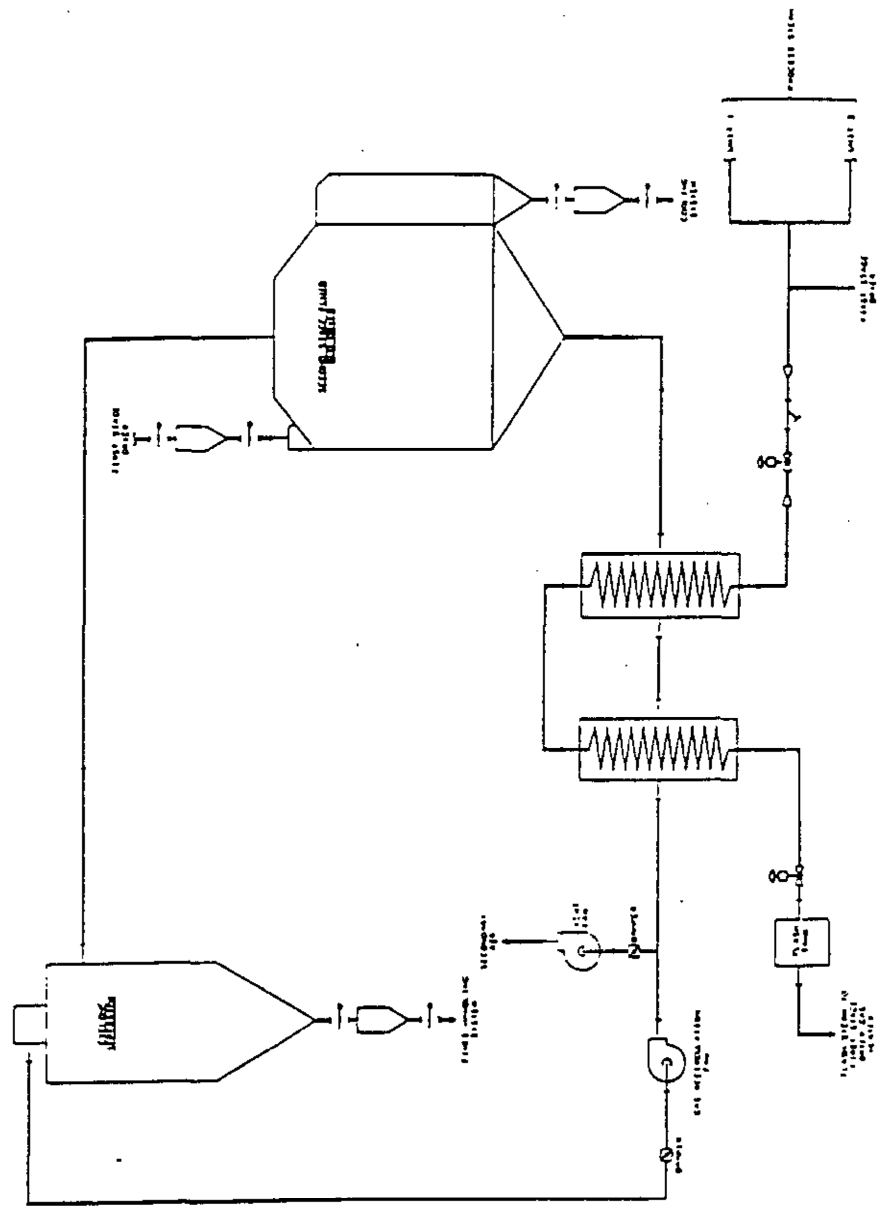
The lignite from the supply system enters the first-stage drying system which is shown on Figure 5-1. The first-stage dryer is composed of a closed loop system which recirculates steam through a static fluidized bed dryer. This steam is generated as moisture is evaporated from the lignite. Any particulates which are carried over from the dryer are recovered in the cyclone separator and directed to the fines handling system. The steam heater heats the lignite in the bed to a temperature of approximately 240° F. This stage of the process drives off what is mostly surface moisture and lowers the lignite moisture content to approximately 12 percent. As the moisture is driven off, the pressure in the loop tends to rise, and is controlled by a modulating vent valve which vents the steam to the existing Unit 2 stack.

The lignite from the first-stage drying system enters the second-stage drying system which is shown on Figure 5-2. The second-stage drying loop is similar to the first-stage loop but differs in operating temperatures. The recirculation gas operates at approximately 600° F and the bed operates at approximately 450° F. These high temperatures cause some of the carboxyl groups in the lignite to decompose into carbon dioxide. The carbon dioxide expels the moisture out of the pores of the lignite, lowering the moisture content of the lignite to approximately 3 percent. As the hydrophilic carboxyl groups are replaced by hydrophobic hydrocarbons, the SynCoal's tendency to reabsorb moisture is reduced. The moisture and volatiles which are driven off of the lignite will be vented to the secondary air duct of Unit 2.

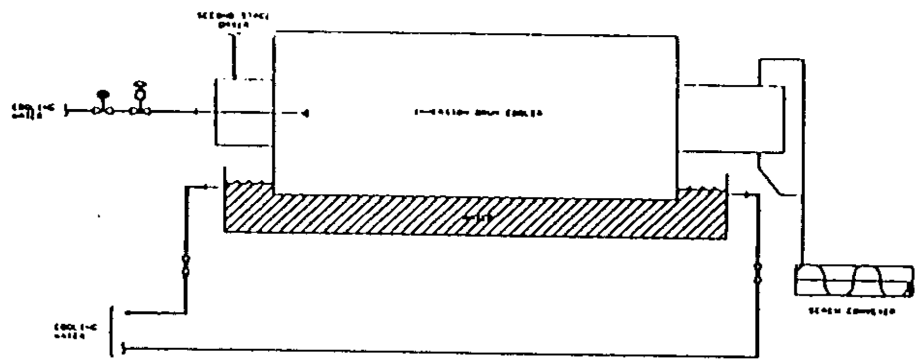
The dried product from the second stage enters the cooling system which is shown on Figure 5-3. The SynCoal enters a finned drum cooler which is partially immersed in cooling water and cools the SynCoal by indirect and direct contact with water. The SynCoal is cooled down to approximately 150° F to ensure that its oxidation rates will be within acceptable limits as it leaves the system. The final product will enter the product delivery system at a moisture content of approximately 5 percent. The added moisture content improves the product's stability.



First-Stage Drying Loop
Figure 5-1



Second-Stage Dryer Loop
Figure 5-2



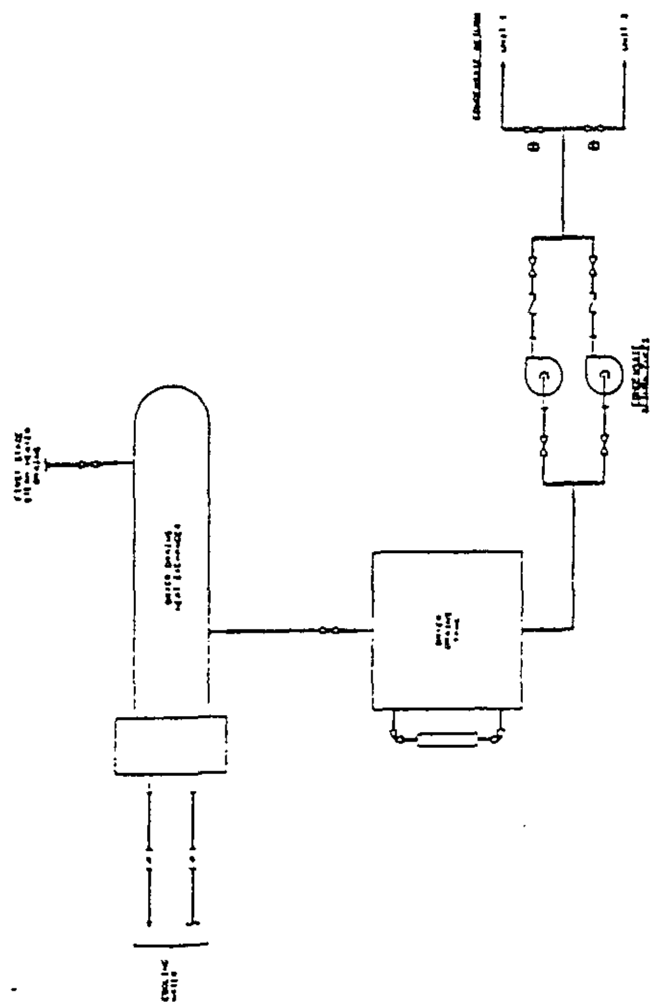
Cooling System
Figure 5-3

The fines handling system receives fines from the first- and second-stage cyclone separators and returns them to a mixing screw conveyor where they are blended with the cooled SynCoal product.

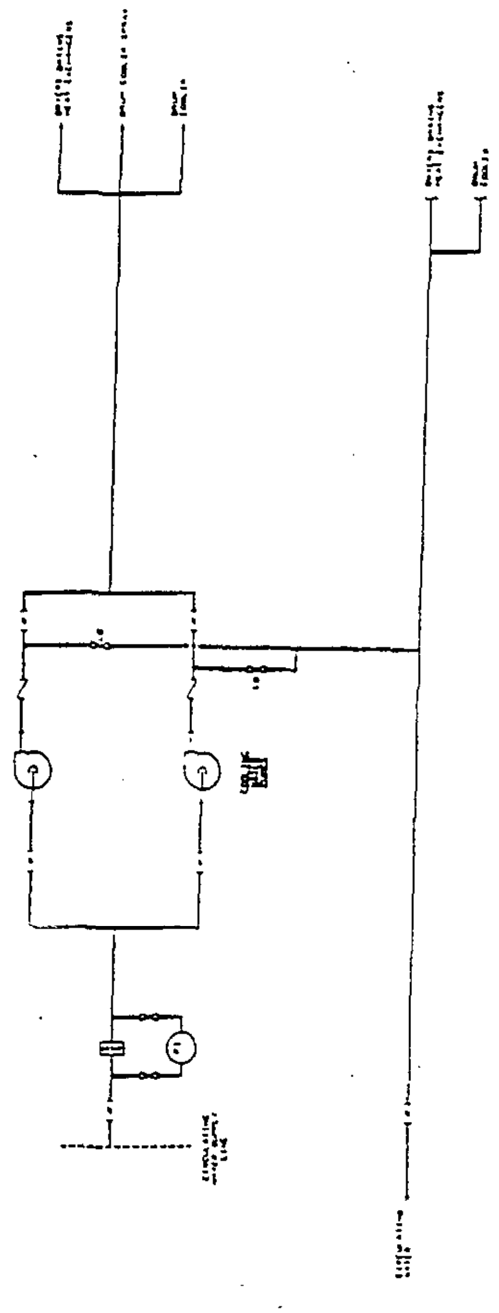
The cooled SynCoal product will be conveyed to a cleaning process to produce the finished SynCoal product. The cleaning process will remove pyritic sulfur as well as most of the inert products in the SynCoal through stratification.

The condensate collection system, shown on Figure 5-4, receives condensate drains from the first-stage dryer steam heater. The condensate is subcooled in the dryer drains heat exchanger and collected in the dryer drains tank. From this tank it is pumped back to the unit supplying the process steam and re-enters the steam cycle directly downstream of the boiler feed pumps.

The auxiliary cooling system receives water from one of the plant circulating water systems downstream of the circulating water pumps, and provides cooling water, via the auxiliary cooling water pumps, to the dryer drains heat exchangers and to the cooling system. The auxiliary cooling water system is shown on Figure 5-5.



Condensate Collection System
Figure 5-4



Auxiliary Cooling Water System
Figure 5-5

6.0 Case Studies

6.1 Base Case

To provide a reference for assessing changes in plant performance for various fuel blends, unit operating loads, and steam to process, a base case was established for each unit using Black & Veatch steam generator and turbine cycle performance models. The base case models for steam generators were developed using typical values for the current as-fired lignite coal with adjustments to reflect actual conditions based on operating data provided by the Milton R. Young Power Station for Unit 1 and Unit 2. The base case models for the turbine cycle were developed from the provided thermal kits using the valves-wide-open, normal pressure case. Models for Unit 1 are based on design outlet superheat and reheat steam temperatures of 1,000° F at full load operation. A review of Unit 2 operating data provided by the station indicated an average superheater steam outlet temperature of approximately 945° F and an average reheat steam outlet temperature of approximately 920° F, as opposed to the 1,000° F superheat and reheat temperatures shown on the provided heat balance. Unit 2 was modeled based on the actual steam conditions indicated in the operating data submitted for review.

6.1.1 Steam Generator Units

Units 1 and 2 are Babcock & Wilcox radiant type steam generator units, with steam reheat, utilizing cyclone furnace combustion units. The capacity rating for the units is based on using an as-mined lignite coal as the fuel. To supply the turbines at valves-wide-open, normal pressure, the design basis for Unit 1 is 1,650,000 lb/h of steam at 1,875 psig and 1,010° F, and the design basis for Unit 2 is 3,050,000 lb/h of steam at 2,495 psig and 1,005° F. Design reheat steam flows for Units 1 and 2 are 1,460,000 lb/h at 432 psig and 1,010° F, and 2,513,000 lb/h at 490 psig and 1,005° F, respectively. Both units are equipped with flue gas recirculation systems for superheated steam temperature control. Unit 1 is equipped with seven 10 foot diameter cyclone furnace combustion units. Unit 2 is equipped with twelve 10 foot diameter cyclone units.

The installed units typically meet or exceed the design value for main and reheat steam flows. The steam temperatures from Unit 1 are slightly less than design values. The Unit 1 main steam temperature is typically about 987° F, and the reheat steam temperature is typically about 995° F. Both the main steam (final superheater outlet) and reheat steam temperatures from Unit 2 are significantly less than design values. Typical Unit 2 main steam temperatures are around 932° F, and reheat steam temperatures are around 917° F. Minnkota Power Cooperative (MPC) indicates that a project is underway to make significant modifications to superheater and reheater surfaces to increase the steam temperatures. MPC has indicated that the heat transfer surface modifications transmitted to Black & Veatch are expected to raise main and reheat steam temperatures by about 80° F.

Each cyclone unit is equipped with a fuel feed and preparation system consisting of a coal feeder, a hammer mill type crushing unit, and a two-stage drying system. The coal is fed from a silo to a crushing unit by a coal feeder. The speed of the feeder changes in response to steam demand. Hot air from the primary air system is introduced into the coal feed chute to the coal crusher. This first stage of drying air evaporates about 10 percent of the moisture in the coal and conveys the crushed coal to a cyclone separator unit which separates the crushed coal from the air stream and discharges the coal into a surge hopper. First-stage air, and a small amount of fine coal product not removed in the cyclone separator, is discharged into the flue gas recirculation plenum on the steam generator unit. Coal from the first-stage drying system is discharged through a rotary valve into the preheated primary air stream which evaporates additional moisture from the fuel as the coal is conveyed to the cyclone furnace combustion units. As designed, the first-stage drying air and second-stage drying air (primary air) streams are each about 12 percent of the total combustion airflow to the boiler.

The first step in developing a basis for evaluating the existing operation of the steam generating units, as well as the operation associated with various fuel preparation plant operation scenarios, was to establish typical fuel values. Using coal analyses for the current as-fired lignite coal and product analyses from a pilot plant operation demonstrating the proposed coal drying technology, the fuel analyses summarized in Table 6-1 were established.

With the fuel properties established, a spreadsheet was developed which calculated the heat absorbed by the feedwater for various main steam and reheat steam flows, and feedwater and blowdown flows. The spreadsheet also calculates the properties of the coal blend (base case is 100 percent by weight as-fired present fuel) used in each case. The spreadsheet then calculates combustion air and flue gas mass and volumetric flows, heat losses in accordance with the ASME Power Test Code heat loss method procedures, the boiler thermal efficiency, the fuel heat input required, the total weight of the blended fuel required and the weights of the present as-received coal, and SynCoal product comprising the blend. An initial run was made

Table 6-1
Typical Coal Properties

Fuel Analysis, percent by weight	Present Fuel		SynCoal
	Dry	As-Fired	As-Fired
Carbon	66.19	42.25	65.54
Hydrogen	4.11	2.62	4.01
Sulfur	1.68	1.07	1.64
Oxygen	16.85	10.76	16.43
Nitrogen	0.92	0.59	0.90
Moisture	--	36.17	2.50
Ash	10.25	6.54	9.99
Total	100.00	100.00	100.00
Higher Heating Value, Btu/lb	11,067	7,064	10,790

based on design values for combustion air temperatures, flue gas temperatures at the exit from the air heater, feedwater temperatures, and main and reheat steam properties. Properties of the fuel for the cases studied which use a blend of the current as-fired lignite and SynCoal are based on utilizing 30 t/h of fines from the SynCoal process. The coal blend properties were used as input to the steam generator model.

The performance of the boiler was modeled using the Black & Veatch Integrated Plant Model (IPM). Information on all heat transfer surfaces in each boiler was entered along with desired steam flows, feedwater flow and feedwater properties, and the combustion air temperature. The boiler models include elements to simulate all water- and steam-cooled wall surfaces. For the base case, 100 percent present as-received coal, the model output was compared to summaries of recent boiler operations, and the models were adjusted to conform the model output to reflect current operations.

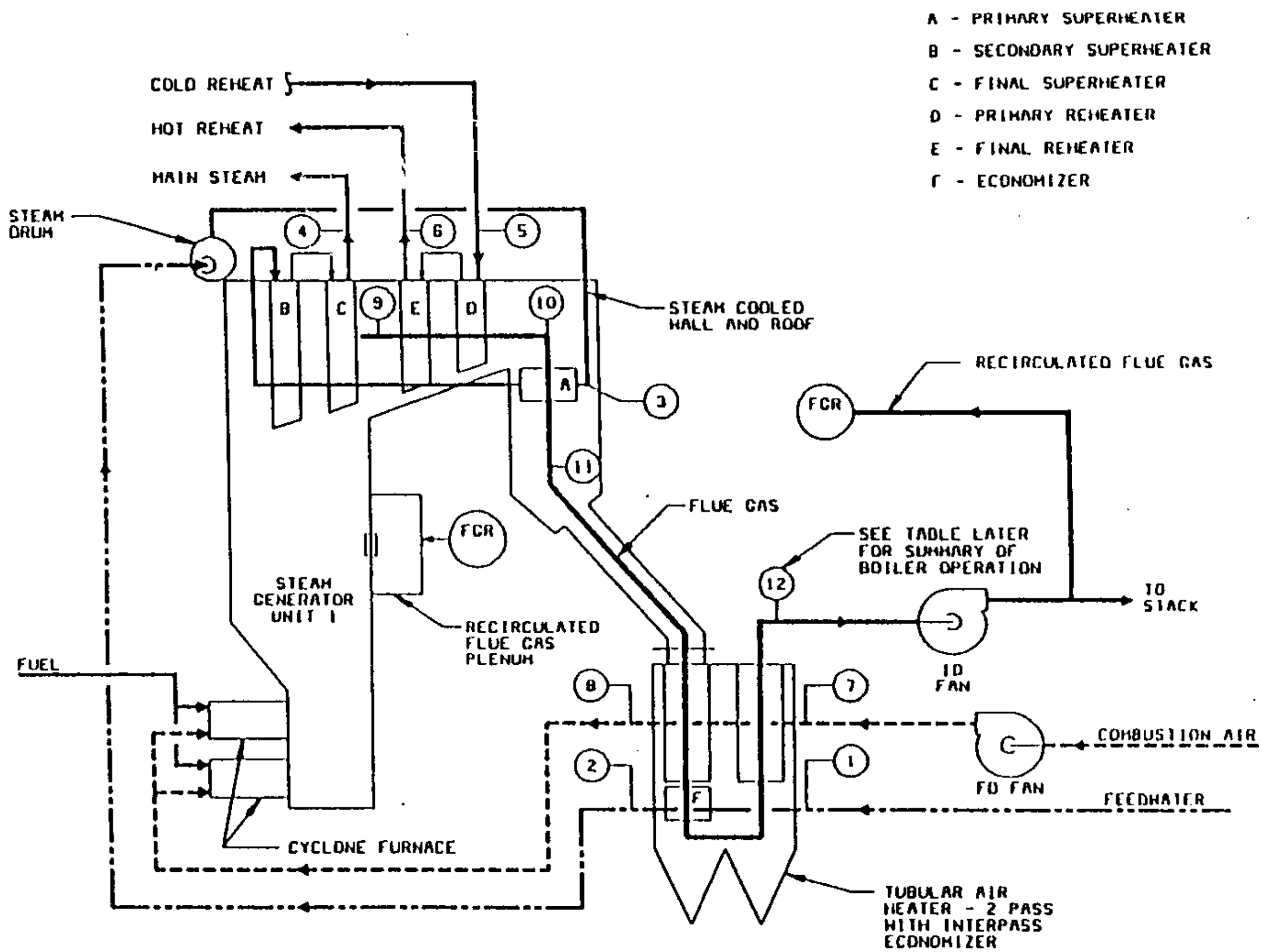
An initial model for Unit 2 was developed based on the existing unit and calibrated using current performance data provided by MPC. Because MPC indicated that Unit 2 will have the heat transfer surfaces modified to increase steam temperatures, a second model was developed based on the design drawings for the surface modifications provided by MPC and the changes in steam temperatures predicted by the surface modification designer's modeling. Initial modifications to Black & Veatch's IPM, based only on the surface modifications indicated on the drawings submitted, yielded different temperatures than indicated by design data provided by MPC. Adjustments in the IPM model were made to conform the model output to approach MPC's design data conditions for the current as-received lignite.

The modeling output for Unit 1 is summarized in Table 6-2. The location of the data points for Unit 1 are shown on Figure 6-1. The modeling output for Unit 2 is summarized in Table 6-3. The location of the data points for Unit 2 is shown on Figure 6-2. Modeling was performed with the flue gas recirculation rate provided by MPC.

The information on boiler outlet steam conditions was provided to the group modeling the turbine cycle. Output from the steam generator IPM and the turbine cycle model were entered into the spreadsheet, previously discussed, to finalize the heat input to the feedwater, fuel blend characteristic, boiler efficiency, quantity of fuel required, and combustion air and flue gas flow values. The data for Unit 1 and Unit 2 are summarized in Tables 6-4 and 6-5, respectively.

Table 6-2
Summary of Unit 1 Boiler Performance Impacts

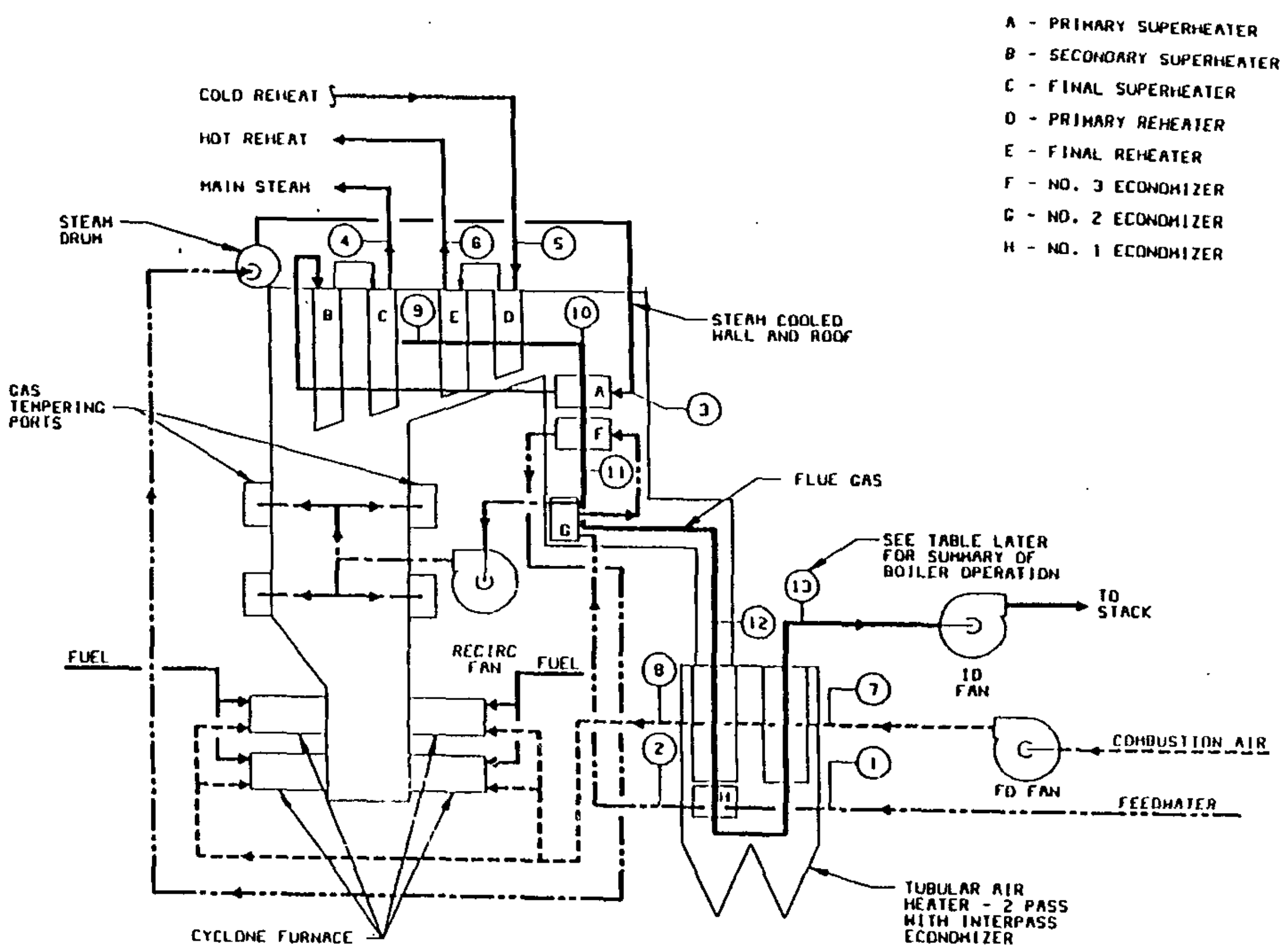
	Revised Base Case		Case A1		Case B1	
	Temperature (°F)	Enthalpy (Btu/lb)	Temperature (°F)	Enthalpy (Btu/lb)	Temperature (°F)	Enthalpy (Btu/lb)
Feedwater						
1. Economizer Inlet	460	446.1	460	444.2	465	445.3
2. Economizer Outlet	480	465.4	475	458.0	475	461.6
Main Steam						
3. Primary SH Inlet	650	1,119.0	650	1,119.0	650	1,119.0
4. Final SH Outlet	987	1,471.8	1,005	1,482.9	965	1,458.6
Reheat Steam						
5. Primary RH Inlet	645	1,337.2	665	1,337.2	665	1,337.2
6. Final RH Outlet	995	1,518.7	1,005	1,524.2	985	1,512.6
Combustion Air						
7. Air Heater Inlet	80	--	80	--	80	--
8. Air Heater Outlet	900	--	870	--	850	--
Flue Gas						
9. Furnace Exit	1,820	--	1,880	--	1,820	--
Final RH Exit	1,590		1,640		1,580	
10. Primary RH Exit	1,400	--	1,450	--	1,390	--
Primary SH Inlet	1,290		1,335		1,275	
11. Primary SH Outlet	855	--	880	--	845	--
Recirculated Flue Gas	345		350		325	
Air Heater Inlet	855		880		845	
Economizer Inlet	605		620		595	
Economizer Outlet	560		575		555	
12. Air Heater Outlet	335	--	350	--	325	--



Unit 1 Boiler Flow Diagram
Figure 6-1

Table 6-3
Summary of Unit 2 Boiler Performance Impacts

	Revised Base Case		Case A2	
	Temperature (°F)	Enthalpy (Btu/lb)	Temperature (°F)	Enthalpy (Btu/lb)
Feedwater				
1. Economizer Inlet	480	464.0	480	464.0
2. Economizer Outlet	630	665.6	635	670.6
Main Steam				
3. Primary SH Inlet	685	1,056.1	685	1,056.1
4. Final SH Outlet	985	1,448.5	1,005	1,461.6
Reheat Steam				
5. Primary RH Inlet	560	1,268.1	560	1,268.1
6. Final RH Outlet	985	1,512.6	1,005	1,523.0
Combustion Air				
7. Air Heater Inlet	80	--	80	--
8. Air Heater Outlet	605	--	600	--
Flue Gas				
9. Furnace Exit Final RH Inlet	1,735 1,600	--	1,755 1,620	--
10. Primary RH Exit Corner RH Outlet	1,325 1,215	--	1,350 1,235	--
11. Primary SH Outlet Economizer 3 Outlet Recirculated FG	980 825 540	--	995 835 545	--
12. Air Heater Inlet AH First Pass Outlet Economizer 1 Outlet	825 610 505	--	835 620 505	--
13. Air Heater Outlet	340	--	350	--



Unit 2 Boiler Flow Diagram
Figure 6-2

Table 6-4
Summary of Unit 1 Boiler Performance

	As-Operated Base Case	Case A1	Case B1
Main Steam Flow, lb/h	1,682,400	1,692,300	1,695,500
Process Steam Flow, lb/h	0	213,000	0
Reheat Steam Flow, lb/h	1,510,200	1,504,500	1,522,100
Feedwater Flow, lb/h	1,717,000	1,944,000	1,730,000
Feedwater Temperature, °F	463	461	464
Heat Absorbed, million Btu/h	2,007.60	2,087.87	2,030.37
As-Received Coal Weight, percent	100	100	80
SynCoal Product Weight, percent	0	0	20
Fuel Analysis, percent weight			
Carbon	42.25	42.25	46.71
Hydrogen	2.62	2.62	2.90
Sulfur	1.07	1.07	1.19
Oxygen	10.76	10.76	11.89
Nitrogen	0.59	0.59	0.65
Moisture	36.17	36.17	29.43
Ash	6.54	6.54	7.23
Total	100.00	100.00	100.00
HHV, Btu/lb	7,064	7,064	7,810
Excess Air, percent	28	28	28
Total Dry Air, lb/lb fuel	6.87	6.87	7.59
Total Air H_2O, lb/lb fuel	0.09	0.09	0.10
Wet Flue Gas, lb/lb fuel	7.89	7.89	8.62
Heat Losses			
CO_2, Btu/lb fuel	79.01	83.65	83.92
H_2O, sensible Btu/lb fuel	78.85	83.48	72.11
H_2O, latent Btu/lb fuel	621.72	621.72	577.57
SO_2, Btu/lb fuel	0.82	0.87	0.87
O_2, Btu/lb fuel	19.47	20.62	20.68
N_2, Btu/lb fuel	337.13	356.96	358.10
Ash Loss at 0.4%, Btu/lb fuel	28.26	28.26	31.24
Radiation at 0.19%, Btu/lb fuel	13.42	13.42	14.84
Unburned Carbon, Btu/lb fuel	7.06	7.06	7.81
Unaccounted at 1.1%, Btu/lb fuel	77.70	77.70	85.91
Total Heat Loss, Btu/lb fuel	1,263.44	1,293.75	1,253.05
Heat Loss, percent heat input	17.89	18.31	16.04
Boiler Efficiency, percent	82.11	81.69	83.96
Fuel Heat Input, million Btu/h	2,444.88	2,555.99	2,418.40
Fuel Blend Feed, t/h	167.60	175.22	149.96
As-Received Coal Feed, t/h	167.60	175.22	119.95
SynCoal Product Feed, t/h	0.00	0.00	30.01
Combustion Airflow, lb/h	2,333,000	2,439,000	2,307,000
Combustion Airflow, scfm at 60° F	516,000	539,000	510,000
Flue Gas Flow, lb/h	2,646,000	2,766,000	2,585,000
Flue Gas Flow, scfm at 60° F	580,000	606,000	562,000
Flue Gas Exit Temperature, °F	335	350	325
Flue Gas Flow, acfm	379,000	389,000	372,000

Table 6-5
Summary of Unit 2 Boiler Performance

	As-Operated Base Case	Case A2
Main Steam Flow, lb/h	3,271,000	3,271,000
Process Steam Flow, lb/h	0	224,000
Reheat Steam Flow, lb/h	2,827,500	2,852,700
Feedwater Flow, lb/h	3,337,000	3,566,000
Feedwater Temperature, °F	482	482
Heat Absorbed, million Btu/h	3,828.69	4,025.84
As-Received Coal Weight, percent	100	100
SynCoal Product Weight, percent	0	0
Fuel Analysis, percent weight		
Carbon	42.25	42.25
Hydrogen	2.62	2.62
Sulfur	1.07	1.07
Oxygen	10.76	10.76
Nitrogen	0.59	0.59
Moisture	36.17	36.17
Ash	6.54	6.54
Total	100.00	100.00
HHV, Btu/lb	7,064	7,064
Excess Air, percent	28.00	28.00
Total Dry Air, lb/lb fuel	6.87	6.87
Total Air H_2O, lb/lb fuel	0.09	0.09
Wet Flue Gas, lb/lb fuel	7.89	7.89
Heat Losses		
CO_2, Btu/lb fuel	80.55	83.65
H_2O, sensible Btu/lb fuel	80.39	83.48
H_2O, latent Btu/lb fuel	621.72	621.72
SO_2, Btu/lb fuel	0.84	0.87
O_2, Btu/lb fuel	19.85	20.63
N_2, Btu/lb fuel	343.74	356.96
Ash Loss at 0.4%, Btu/lb fuel	28.26	28.26
Radiation at 0.19%, Btu/lb fuel	13.42	13.42
Unburned Carbon, Btu/lb fuel	7.06	7.06
Unaccounted at 1.1%, Btu/lb fuel	77.70	77.70
Total Heat Loss, Btu/lb fuel	1,273.54	1,293.75
Heat Loss, percent heat input	18.03	18.31
Boiler Efficiency, percent	81.97	81.69
Fuel Heat Input, million Btu/h	4,670.75	4,928.46
Fuel Blend Feed, t/h	320.19	337.86
As-Received Coal Feed, t/h	320.19	337.86
SynCoal Product Feed, t/h	0.00	0.00
Combustion Airflow, lb/h	4,456,000	4,702,000
Combustion Airflow, scfm at 60° F	985,000	1,039,000
Flue Gas Flow, lb/h	5,055,000	5,333,000
Flue Gas Flow, scfm at 60° F	1,107,000	1,168,000
Flue Gas Exit Temperature, °F	340	350
Flue Gas Flow, acfm	720,000	750,000

Manual calculations were performed to determine the adiabatic flame temperature and resulting cyclone furnace combustion unit heat absorption rate for various blends of the present as-received lignite coal and the SynCoal product. These values are summarized in Table 6-6.

The heat absorption values presented in Table 6-6 are based on a high viscosity ash, which results in the highest estimated heat absorption rates. Typical cyclone furnace combustion units are designed for heat absorption rates of up to 100,000 Btu/ft^2. While detailed analyses by the steam generator unit manufacturer are required to quantify the impacts of increased heat absorption relative to waterwall circulation, Table 6-6 values suggest that the additional heat transfer within the cyclone furnace as a result of higher flame temperatures is within the design range of typical cyclone furnace units.

6.1.2 Unit 1 Steam Turbine Cycle

Unit 1 consists of a six feedwater heater cycle with a General Electric condensing steam turbine rated at 234.5 MW and operating at a back pressure of 1.5 inches HgA. The generator is rated at 285,000 KVA at 45 psig H_2 pressure. The existing generator is liquid cooled. Unit 1 has a net plant output of 244 MW, a net turbine heat rate of 8,255 Btu/kWh, and a net plant heat rate of 10,810 Btu/kWh (HHV). Design throttle conditions into the turbine are 1,816 psia/1,000° F/1,000° F. The boiler feed pump is motor-operated. The condenser was modeled to allow the back pressure to fluctuate at the different load points. The valves-wide-open, normal pressure heat balance that was provided in the thermal kit was modeled utilizing an in-house thermal cycle performance program for the design case. While the operating conditions mentioned were used as the design of the thermal model, the base case used for comparison purposes models current operating conditions. Unit 1 currently operates in baseload capacity, 1,682,000 lb/h at 1,823 psia with a 987° F superheat temperature and a 995° F hot reheat temperature. This unit produces 230.6 MW after taking into account auxiliary requirements of 16.4 MW. Unit 1 has a net turbine heat rate of 8,305 Btu/kWh and a net plant heat rate of 10,835 Btu/kWh (HHV). Table 6-7 contains a performance summary of the current operating parameters for the Unit 1 base case.

Table 6-6
Adiabatic Flame Temperature and Cyclone Heat Absorption Rate

Blend, percent weight	Unit 1		Unit 2	
As-Received/ SynCoal Product	Temperature, (°F)	Heat Absorbed, Btu/ft^2	Temperature, (°F)	Heat Absorbed, Btu/ft^2
100/0	3,280	50,000	3,280	50,000
80/20	3,400	51,500	--	--

Table 6-7
Thermal Cycle Plant Performance
Milton R. Young Power Station--Base--Unit 1

Main Steam Conditions from Boiler	
Flow Rate, lb/h	1,682,000
Pressure, psia	1,823
Temperature, °F	987
Enthalpy, Btu/lb	1,471.8
Steam to Process	
Flow Rate, lb/h	0
Pressure, psia	1,823
Temperature, °F	987
High-Pressure Turbine Throttle Steam	
Flow Rate, lb/h	1,682,000
Pressure, psia	1,823
Temperature, °F	987
Hot Reheat Steam to IP Turbine Admission	
Flow Rate, lb/h	1,510,200
Pressure, psia	460
Temperature, °F	995
Low-Pressure Turbine Admission Steam	
Flow Rate, lb/h	1,404,100
Pressure, psia	160
Temperature, °F	738
Feedwater Return	
Flow Rate, lb/h	1,682,000
Pressure, psia	2,269
Temperature, °F	463
Performance Summary	
Boiler Efficiency, percent	82.10
Net Turbine Output, kW	247,000
Net Turbine Heat Rate, Btu/kWh	8,305
Total Heat Input, MBtu/h	1,999.5
Auxiliary Power, kW	16,400
Net Plant Output, kW	230,600
Net Plant Heat Rate, Btu/kWh (HHV)	10,835
NTHR Charged to Power, Btu/kWh	--
NPHR Charged to Power, Btu/kWh (HHV)	--
Condenser Backpressure, in psia	1.74

6.1.3 Unit 2 Steam Turbine Cycle

Unit 2 consists of a seven feedwater heater cycle with a Westinghouse condensing steam turbine rated at 438.6 MW and operating at a back pressure of 2.0 inches HgA. The generator is rated at 530,000 KVA at H_2 pressure of 60 psig. Unit 2 has a net plant output of 397.2 MW, a net turbine heat rate of 8,065 Btu/kWh, and a net plant heat rate of 10,840 Btu/kWh. Design throttle conditions into the turbine are 2,415 psia/945° F/920° F. The boiler feed pump is turbine operated. The condenser was modeled to allow the back pressure to fluctuate at the different load points. The valves-wide-open, normal pressure heat balance that was provided in the thermal kit was modeled utilizing an in-house thermal cycle performance program for the design case. While the operating conditions mentioned were used as the design of the thermal model, the base case used for comparison purposes models current operating conditions adjusted for the installation of the proposed tube surface modifications. Unit 2 currently operates in baseload capacity, 3,270,600 lb/h at 2,478 psia with a 986° F superheat and reheat temperature. This unit produces 447.1 MW after taking into account auxiliary requirements of 33.9 MW. Unit 2 has a net turbine heat rate of 7,780 Btu/kWh and a net plant heat rate of 10,205 Btu/kWh (HHV). Table 6-8 contains a performance summary of the Unit 2 base case.

6.2 Case A

Case A is based on all SynCoal being sold offsite.

6.2.1 Case A1

Case A1 is based on all process steam supplies from Unit 1. This case has no effect on the performance of Unit 2. The following subsections address Unit 1 performance for Case A1.

6.2.1.1 Cycle Efficiency. In Case A1, 1,692,300 lb/h of steam is provided by the Unit 1 steam generator at 1,823 psia and 1,005° F with a reheat temperature of 1,005° F. Unit 1 produces 229.3 MW after taking into account auxiliary power requirements of 17.7 MW. For this case, Unit 1 has a net turbine heat rate of 9,075 Btu/kWh and a net plant heat rate of 11,965 Btu/kWh (HHV). In order to keep the output the same for Case A1, it is necessary to increase the main steam flow of the boiler by increasing the heat input to account for the 216,800 lb/h (210 MBtu/h) of process steam required by process. The process steam, which is extracted from the steam drum, is sent to the drying facility which drys lignite coal.

Table 6-8
Thermal Cycle Plant Performance
Milton R. Young Power Station--Base--Unit 2

Main Steam Conditions from Boiler	
Flow Rate, lb/h	3,270,600
Pressure, psia	2,478
Temperature, °F	986
Enthalpy, Btu/lb	1,448.8
Steam to Process	
Flow Rate, lb/h	0
Pressure, psia	2,478
Temperature, °F	986
High-Pressure Turbine Throttle Steam	
Flow Rate, lb/h	3,270,600
Pressure, psia	2,478
Temperature, °F	986
Hot Reheat Steam to IP Turbine Admission	
Flow Rate, lb/h	2,872,500
Pressure, psia	525
Temperature, °F	986
Low-Pressure Turbine Admission Steam	
Flow Rate, lb/h	2,494,500
Pressure, psia	144
Temperature, °F	663
Feedwater Return	
Flow Rate, lb/h	3,270,600
Pressure, psia	3,215
Temperature, °F	482
Performance Summary	
Boiler Efficiency, percent	82.00
Net Turbine Output, kW	481,000
Net Turbine Heat Rate, Btu/kWh	7,780
Total Heat Input, MBtu/h	3,742
Auxiliary Power, kW	33,900
Net Plant Output, kW	447,100
Net Plant Heat Rate, Btu/kWh (HHV)	10,205
NTHR Charged to Power, Btu/kWh	--
NPHR Charged to Power, Btu/kWh (HHV)	--
Condenser Backpressure, in HgA	1.02

The SynCoal that is produced by the drying facility is sold offsite while Unit 1 and Unit 2 burn the lignite as fuel. All steam sent to the dryer is returned to Unit 1 as condensate at 100 psia and 200° F to the deaerator. While Unit 1 is providing the steam necessary to operate the drying system, Unit 2 operates in baseload capacity (3,270,600 lb/h at 2,478 psia and 986° F) producing 447.1 MW after taking into account auxiliary requirements of 33.9 MW. Unit 2 has a net turbine heat rate of 7,780 Btu/kWh and a net plant heat rate of 10,205 Btu/kWh (HHV). Table 6-9 gives a summary on Unit 1 performance for Case A1.

6.2.1.2 Operating Parameters. There is no significant change in the output of Unit 1 in Case A1 due to the extraction of 216,800 lb/h of process steam. The net plant output for Unit 1 is 229.3 MW, a decrease of 1.3 MW. To accomplish the same output, the heat input to the Unit 1 steam generator is increased from 2,445 MBtu to 2,556 MBtu, an increase of 111 MBtu (4.5 percent increase).

6.2.1.3 Boiler Operation. In Case A1, about 213,000 lb/h of process steam is provided from the steam drum of Unit 1, and the boiler is fired with the current as-received lignite. The process steam flow from Unit 1 provides thermal energy equivalent to about 210 million Btu per hour required by two SnyCoal drying systems, each with a design feed rate of 100 t/h. Firing the unit harder to produce the process steam and provide the steam required to maintain the current generator output results in an increase in the air heater flue gas exit temperature of about 15° F, from 335° F to 350° F. This increase in the temperature of the flue gas results in a decrease in the thermal efficiency of the boiler from about 82.1 percent to 81.7 percent. However, both the main steam and reheat steam temperatures are increased from current values to about 1,005° F. Superheat and reheat system attemperator spray flows of about 69,000 lb/h and 23,000 lb/h, respectively, are required to maintain the steam temperatures at design values.

6.2.2 Case A2

Case A2 is based on all process steam being supplied from Unit 2. This case has no effect on the performance of Unit 1. The following subsections address Unit 2 performance for Case A2.

6.2.2.1 Cycle Efficiency. In Case A2, 3,270,600 lb/h of steam is provided by Unit 2 at 2,478 psia and 1,005° F with a reheat temperature of 1,005° F. Unit 2 produces 449.2 MW after taking into account auxiliary power requirements of 33.9 MW. For this case, Unit 2 has a net turbine heat rate of 8,280 Btu/kWh and

Table 6-9
Thermal Cycle Plant Performance
Milton R. Young Power Station--Case A1--Unit 1

Main Steam Conditions from Boiler	
Flow Rate, lb/h	1,692,300
Pressure, psia	1,823
Temperature, °F	1,005
Enthalpy, Btu/lb	1,482.9
Steam to Process	
Flow Rate, lb/h	216,800
Pressure, psia	2,025
Temperature, °F	638
High-Pressure Turbine Throttle Steam	
Flow Rate, lb/h	1,692,300
Pressure, psia	1,823
Temperature, °F	1,005
Hot Reheat Steam to IP Turbine Admission	
Flow Rate, lb/h	1,504,500
Pressure, psia	460
Temperature, °F	1,005
Low-Pressure Turbine Admission Steam	
Flow Rate, lb/h	1,379,400
Pressure, psia	157
Temperature, °F	743
Feedwater Return	
Flow Rate, lb/h	1,909,100
Pressure, psia	2,269
Temperature, °F	461
Performance Summary	
Boiler Efficiency, percent	81.70
Net Turbine Output, kW	247,000
Net Turbine Heat Rate, Btu/kWh	9,075
Total Heat Input, MBtu/h	2,177.8
Auxiliary Power, kW	17,700
Net Plant Output, kW	229,300
Net Plant Heat Rate, Btu/kWh (HHV)	11,965
NTHR Charged to Power, Btu/kWh	8,200
NPHR Charged to Power, Btu/kWh (HHV)	10,845
Condenser Backpressure, in psia	1.70

a net plant heat rate of 10,900 Btu/kWh (HHV). The higher main steam and reheat temperatures are due to extracting steam from the steam drum for process requirements (232,200 lb/h, 210 MBtu/h). The higher superheat and reheat temperatures allow Unit 2 to produce more output with the same boiler flow. In this case, the steam that is extracted from the boiler drum for the drying facility which drys the lignite coal, returns as condensate at 100 psia and 200° F to the deaerator. The coal that is dried by the drying facility is sold offsite, while Unit 1 and Unit 2 burn the lignite as fuel. While Unit 2 is providing the steam necessary to operate the drying system, Unit 1 operates at baseload capacity. Table 6-10 gives a summary of Unit 2 performance for Case A2.

6.2.2.2 Operating Parameters. There is a slight increase in the output of Unit 2 in Case A2 due to the elevation of steam temperatures caused by the extraction of 234,000 lb/h of process steam from the drum. The net plant output for Unit 2 is 483.1 MW, an increase of 2.1 MW from the base case. To accomplish this increase, along with the process extraction, the heat input to the steam generator is increased from 4,671 MBtu to 4,928 MBtu, an increase of 257 MBtu (5.5 percent).

6.2.2.3 Boiler Operation. In Case A2, about 234,000 lb/h of process steam is provided from the steam drum of Unit 2, and the boiler is fired with the current as-received lignite. Modeling of the unit also included introducing about 50,000 lb/h of water vapor vented from the second stage of the SynCoal process into the combustion air stream after the air preheater. The process steam flow from Unit 2 provides thermal energy equivalent to about 210 million Btu per hour required by two SynCoal drying systems, each with a design feed rate of 100 t/h. Firing the unit harder to produce the process steam and provide the steam required to maintain current steam flow to the generator system results in an increase in the air heater flue gas exit temperature of about 10° F, from 340° F to 350° F. This increase in the temperature of the flue gas results in a decrease in the thermal efficiency of the boiler from about 82 percent to 81.7 percent. However, the increased energy input and flue gas flow increases main and reheat steam values from about 985° F to about 1,005° F. Superheat and reheat system attemperator spray flows of about 31,500 lb/h and 7,200 lb/h, respectively, are required to maintain the steam temperatures at design values. The increase in main and reheat steam temperatures results in an increase in the net plant electrical output of about 2.1 MW as discussed in Subsection 6.2.2.2.

Table 6-10 Thermal Cycle Plant Performance Rosebud--Case A2--Unit 2	
Main Steam Conditions from Boiler	
Flow Rate, lb/h	3,270,600
Pressure, psia	2,478
Temperature, °F	1,005
Enthalpy, Btu/lb	1,461.6
Steam to Process	
Flow Rate, lb/h	232,200
Pressure, psia	2,675
Temperature, °F	678
High-Pressure Turbine Throttle Steam	
Flow Rate, lb/h	3,270,600
Pressure, psia	2,478
Temperature, °F	1,005
Hot Reheat Steam to IP Turbine Admission	
Flow Rate, lb/h	2,852,700
Pressure, psia	525
Temperature, °F	1,005
Low-Pressure Turbine Admission Steam	
Flow Rate, lb/h	2,428,800
Pressure, psia	141
Temperature, °F	673
Feedwater Return	
Flow Rate, lb/h	3,502,800
Pressure, psia	3,215
Temperature, °F	482
Performance Summary	
Boiler Efficiency, percent	81.70
Net Turbine Output, kW	483,100
Net Turbine Heat Rate, Btu/kWh	8,280
Total Heat Input, MBtu/h	4,000.6
Auxiliary Power, kW	33,900
Net Plant Output, kW	449,200
Net Plant Heat Rate, Btu/kWh (HHV)	10,900
NTHR Charged to Power, Btu/kWh	7,860
NPHR Charged to Power, Btu/kWh (HHV)	10,350
Condenser Backpressure, in psia	1.00

6.3 Case B

Case B is based on 30 t/h of SynCoal product being burned in the existing units. Only Case B1, in which Unit 1 burns SynCoal, was analyzed. The combustion of SynCoal in Unit 2 was not modeled because Unit 2 presently experiences depressed steam temperatures and the further reduction in steam temperatures caused by SynCoal would result in a lowered output at the valves-wide-open condition.

6.3.1 Case B1

Case B1 is based on Unit 1 burning 30 t/h of SynCoal. The process steam is not supplied from Unit 1 in this case. Since Unit 1 presently operates with maximum steam temperatures, the extraction of steam from Unit 1 could only have detrimental effects. Therefore, the process steam must be supplied from Unit 2. For Unit 1 to be operating in the condition modeled by Case B1, Unit 2 must be operating under Case A2 conditions.

6.3.1.1 Cycle Efficiency. In Case B1, 1,695,500 lb/h of steam is provided by Unit 1 at 1,823 psia and 986° F with a reheat temperature of 983° F. Unit 1 burns 30 t/h of the SynCoal. Unit 2 provides 210 MBtu/h of process steam to the process. The superheat and reheat temperatures decrease in Unit 1 due to burning SynCoal. In order to produce the desired output, main steam flow is increased to 1,695,500 lb/h by increasing the heat input into the boiler. Unit 1 produces 230.9 MW after taking into account auxiliary requirements of 16.4 MW. For this case, Unit 1 has a net turbine heat rate of 8,325 Btu/kWh and a net plant heat rate of 10,615 Btu/kWh (HHV). The boiler efficiency increases approximately 2 percent when burning the SynCoal although the main steam temperature decreases by 21° F. Table 6-11 gives a summary of Unit 1 performance for Case B1.

6.3.1.2 Operating Parameters. In Case B1, Unit 1 burns 30 t/h of SynCoal. As discussed further in Subsection 6.3.1.3, the use of SynCoal results in lower main steam and reheat temperatures. A net plant output of 230.6 MW, the same as for the base case, was achieved by increasing the steam flow to offset the decrease in steam temperatures. The heat input to the Unit 1 steam generator was 2,418 MBtu/h, a decrease of 27 MBtu (-1.1 percent).

6.3.1.3 Boiler Operation. In Case B1, fines from the SynCoal process are blended into the primary air stream at the inlet to the cyclone furnaces on Unit 1. The fines feed rate is expected to be about 30 t/h. No process steam is provided from Unit 1 in this option and the main fuel continues to be the current as-received lignite. The

Table 6-11 Thermal Cycle Plant Performance Milton R. Young Power Station--Case B1--Unit 1	
Main Steam Conditions from Boiler	
Flow Rate, lb/h	1,695,500
Pressure, psia	1,823
Temperature, °F	986
Enthalpy, Btu/lb	1,471.1
Steam to Process	
Flow Rate, lb/h	0
Pressure, psia	1,823
Temperature, °F	986
High-Pressure Turbine Throttle Steam	
Flow Rate, lb/h	1,695,500
Pressure, psia	1,823
Temperature, °F	986
Hot Reheat Steam to IP Turbine Admission	
Flow Rate, lb/h	1,522,100
Pressure, psia	462
Temperature, °F	983
Low-Pressure Turbine Admission Steam	
Flow Rate, lb/h	1,414,400
Pressure, psia	160
Temperature, °F	728
Feedwater Return	
Flow Rate, lb/h	1,695,500
Pressure, psia	2,269
Temperature, °F	464
Performance Summary	
Boiler Efficiency, percent	84.00
Net Turbine Output, kW	247,000
Net Turbine Heat Rate, Btu/kWh	8,325
Total Heat Input, MBtu/h	2,004.5
Auxiliary Power, kW	16,400
Net Plant Output, kW	230,600
Net Plant Heat Rate, Btu/kWh (HHV)	10,615
NTHR Charged to Power, Btu/kWh	--
NPHR Charged to Power, Btu/kWh (HHV)	--
Condenser Backpressure, in psia	1.75

dry fines result in a decrease in the amount of flue gas produced with corresponding decreases in main and reheat steam temperatures compared to the base case burning 100 percent current as-received lignite. Therefore, the steam flow to the turbine was increased by 13,500 lb/h to overcome the loss of generation due to the decrease in steam temperatures. As modeled to maintain the base case plant electrical output, the blend of as-received lignite and 30 t/h of SynCoal fines results in a decrease in main steam temperatures of 987° F for the base case to 965° F for Case B1. Reheat steam temperatures drop from 995° F to 985° F. While more steam has to be produced to maintain the same electrical output, about 70 million Btu per hour less energy compared to the base case is required to produce the steam because of an increase in boiler efficiency. The boiler efficiency increases from about 82 percent to 84 percent. The increase in efficiency is mainly due to a 10° F lower flue gas exit temperature, and less moisture in the fuel which results in lower sensible and latent heat losses from moisture.

7.0 Required Plant Modifications

7.1 Main Steam System

Cases A and B assume the process steam is extracted from either the Unit 1 or Unit 2 steam drum. To improve operational flexibility, a tap would be made into both steam drums so that the process demand could be supplied by either unit.

A tap into main steam was initially pursued due to the relative ease with which it could be accomplished as compared to a tap into the piping on the steam drum or the IP superheater. The high operating temperatures of the drying facility also dictate that high-pressure steam be used, which eliminates the choice of using reheat steam. During modeling, it was determined that the use of main steam is not feasible from a performance standpoint, and that the preferred source of steam from both Units 1 and 2 is the steam drum.

A tap into the steam drum header of Units 1 and 2 will be made. Due to the location of the tap into the steam drum header, the ASME Boiler and Pressure Vessel Code, Section I, will require post weld heat treatment, radiography, and performance of a hydrostatic test.

7.2 Condensate System

The condensate for all cases has been returned to the deaerator. This provides the best thermodynamic match and avoids the use of high-pressure condensate return pumps at the drying facility by returning the condensate upstream of the boiler feed pumps.

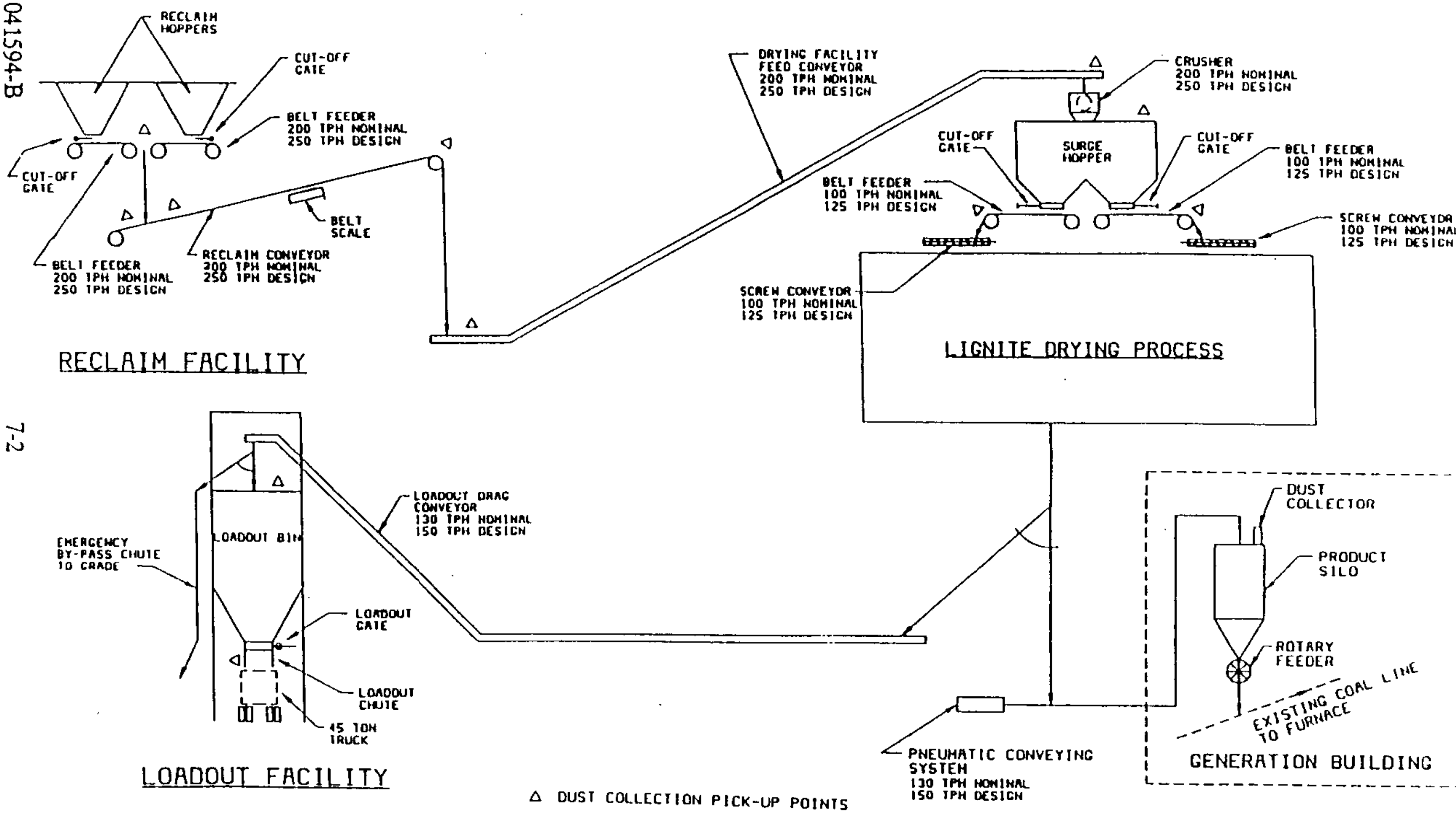
The tap into the condensate system will be a 4 inch line.

7.3 Fuel Handling System

7.3.1 Conveyor Modifications

An evaluation of the existing fuel handling systems was made to determine if a cost-effective modification was possible to convey coal to the drying facility and then deliver the dried product to each steam generator and a loadout facility. The design capacities of the existing conveyors do not have enough design margin to convey an additional 200 t/h to the drying facility. Therefore, a stand-alone conveying system will be installed instead of modifying the existing systems.

Various fuel handling systems were conceptualized and the most attractive system from an economic and operational standpoint is shown on Figure 7-1. Two



Fuel Handling Flow Diagram
Figure 7-1

additional reclaim hoppers will be installed under the Unit 1 active reclaim pile. The approximate location of these hoppers is shown on the Site Layout, Figure 8-1.

Fuel will be conveyed using a reclaim conveyor and drag conveyor to the drying facility where it will be crushed and stored in a surge hopper. The dried product from the process will be transported to a loadout bin by a drag conveyor where it will be transported offsite by 45 ton trucks. The locations of the drying facility and the loadout facility are also shown on Figure 8-1.

Testing done by the Rosebud SynCoal Partnership has shown that if SynCoal and lignite are blended in a silo, the SynCoal tends to channel through, and a good mixture is not retained. Additionally, if SynCoal were introduced into the silos, operational flexibility to use it intermittently would be limited. Therefore, any product which will be burned in Units 1 and 2 will be conveyed to dedicated SynCoal storage bins within the units. SynCoal will be introduced directly into the primary air system before the cyclones as shown on Figure 7-2.

7.3.2 Silo CO_2 Inerting

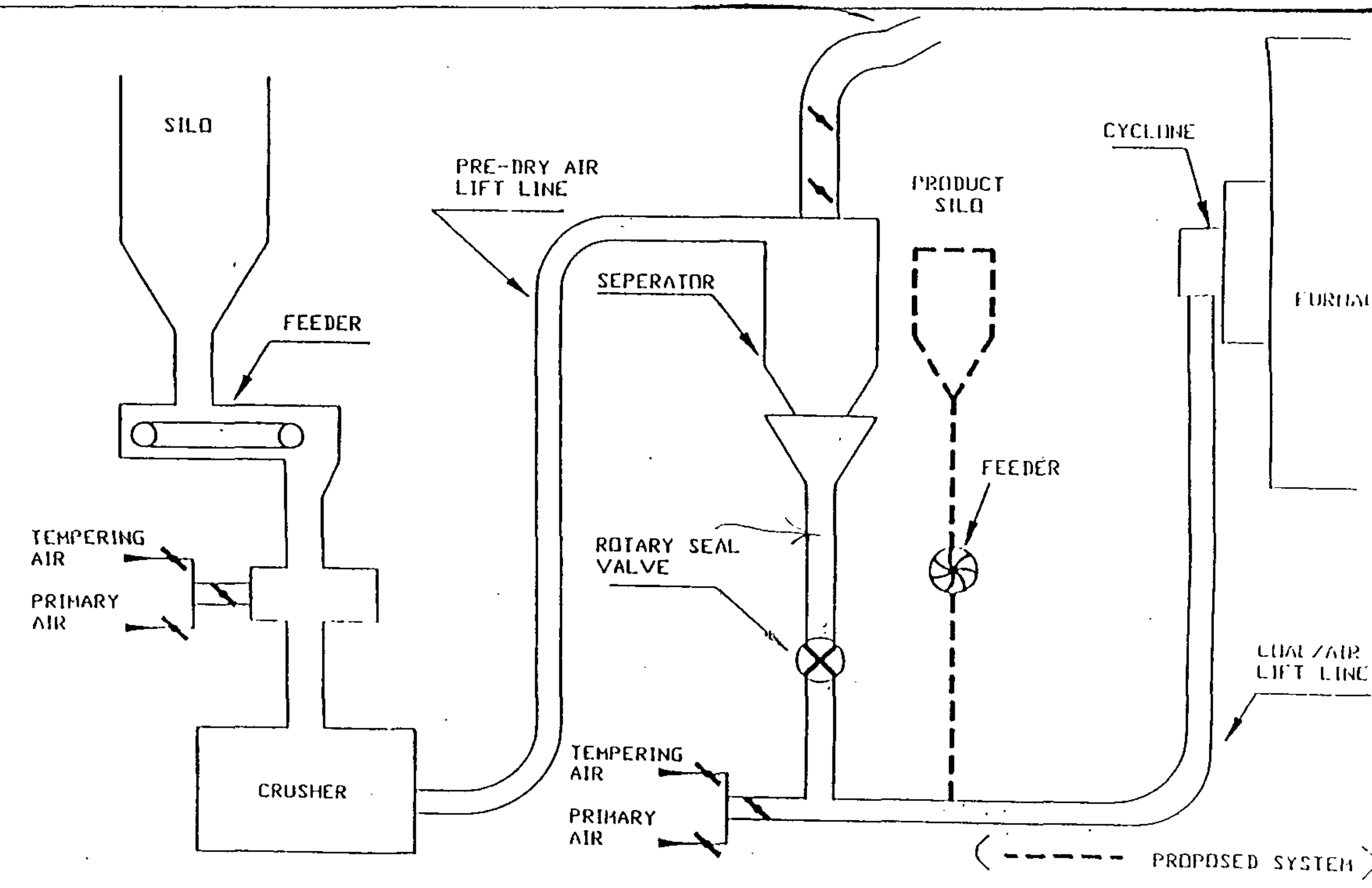
When designing a plant which will burn lignite or subbituminous coal, it is Black & Veatch's standard practice to recommend the installation of a silo inerting system. One CO_2 flooding system will be shared by the dedicated SynCoal storage bins in both units. It will consist of a liquid storage unit with regulator and vaporizer, and will inject CO_2 at the top and bottom of each SynCoal silo. One portable low-expansion foam station will be required for each plant in the event a fire did occur in a silo.

7.3.3 Fuel Train Dust Control

Dust control will be accomplished with the addition of baghouse filters at conveyor chute transfer points. The use of dust-tight drag conveyors and screw conveyors for fuel transfer at the dryer facility will provide for containment of dust emissions at these transfer locations. The dust control pickup points are shown on Figure 7-1.

7.4 Secondary Air System

The SynCoal process dries lignite in two stages. Process information provided indicates that the exhaust of the first stage is a mixture of air and steam, which can be vented to atmosphere with no adverse environmental impacts. The exhaust from the second stage contains hydrocarbons in the form of methane. The concentration



SynCoal Fuel Feed System
Figure 7-2

of methane in the exhaust is estimated to be greater than 1,000 ppm by volume. This requires that the exhaust stream be treated to reduce the hydrocarbon emissions.

Estimates based on pilot plant operations indicate that the second stage of the SynCoal process exhausts about 22,800 lb/h of a gas mixture per drying unit, or a total of 45,600 lb/h for both of the proposed drying units. The second stage exhaust gas stream is referred to as "make gas." It has been suggested that the make gas stream be combined with the combustion air for Unit 2. The high temperatures in the cyclone furnace units are sufficient to burn the methane, and any other unstable components in the make gas stream. Also, temperatures in the main furnace are above the dissociation temperature of methane. Therefore, introducing make gas into the furnace through the recirculation gas system is also a possibility.

The design basis for excess air for Unit 2 is 28 percent, which results in a full load combustion airflow of about 4,240,000 lb/h. The full load combustion air stream contains about 968,600 lb/h of oxygen of which about 755,500 lb/h is required for complete combustion. On a constant weight basis, 4,240,000 lb/h of combustion air, which includes 45,600 lb/h of make gas, contains about 958,800 lb/h of oxygen, or about 9,200 lb/h less oxygen than using 100 percent air. This reduced oxygen in the same quantity of combustion air is equivalent to 27 percent excess air.

At 50 percent load, about 2,120,000 lb/h of combustion air is required for boiler operation with 28 percent excess air. If 100 percent air is used for combustion air, the combustion air stream contains about 484,300 lb/h of oxygen of which about 377,800 lb/h is required for complete combustion. On a constant weight basis, 2,120,000 lb/h of combustion air, which includes 45,600 lb/h of make gas, contains about 475,700 lb/h of oxygen or about 8,600 lb/h less oxygen than using 100 percent air. This reduced oxygen in the same quantity of combustion air is equivalent to 26 percent excess air.

The only negative impact of mixing the SynCoal process make gas exhaust with the combustion air, or using the make gas as recirculated flue gas, is the decrease in boiler efficiency due to the water vapor in the make gas stream. However, because the water is present as vapor, only sensible heat losses result. The 38,300 lb/h of water vapor in the make gas stream more than doubles the water vapor compared to using 100 percent air. But, the additional heat loss associated with this amount of water vapor decreases the overall boiler efficiency by only 0.10 to 0.15 percent.

A potential benefit of the added water vapor is reducing the increase in oxides of nitrogen emissions associated with burning fuel blends with significant amounts of SynCoal product as part of the blend. However, this benefit cannot be quantified and is likely to be very small.

Based on the above, the combustion air system can use the SynCoal process make gas exhaust stream with no significant impacts on boiler operation. The make gas stream can be introduced into the combustion air system before or after the air heater, or the make gas stream could be introduced into the main furnace through the recirculating flue gas system.

7.5 Boiler Modifications

7.5.1 Automatic Boiler Control

The burning of SynCoal should have very little impact on automatic boiler control. The SynCoal will be fed into the steam generators through rotary feeders directly into the primary air. The process steam required for drying will be controlled from the Lignite Drying Facility. Purge permissives, MFT interlocks, fuel firing permissives, and fan and damper interlocks should not change significantly when burning SynCoal.

7.5.2 Codes

The addition of the Lignite Drying Facility will require steam supplies from both steam generating units. The piping and valves will be covered by the ASME Boiler and Pressure Vessel Code.

7.6 Ash Handling

The bottom/fly ash characteristics and production are not expected to change significantly when burning SynCoal. Therefore, no modifications should be required for the ash handling equipment.

8.0 Site Modifications

8.1 Site Layout

The site will require rerouting of existing roads and building of new road as indicated on Figure 8-1. This will be required to accommodate the installation of the loadout facility.

8.2 Traffic

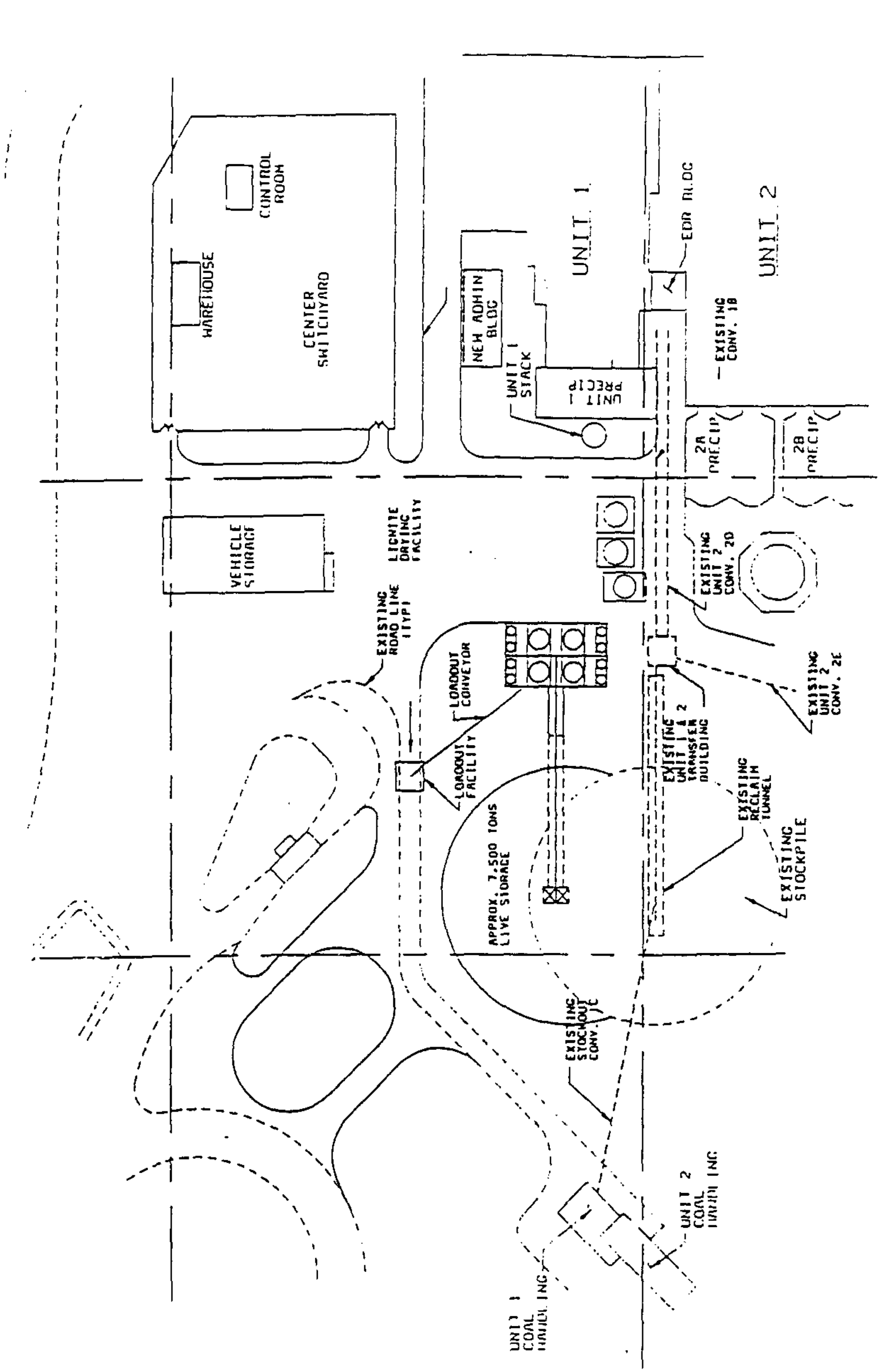
At the maximum output to the loadout facility, as required by Case A, the number of trucks per hour would not pose a traffic problem. Case A would require a loadout truck traffic rate of three 45 ton trucks per hour based on the dryer facility producing 130 t/h. The only possible potential for traffic interference would come from the unloading system operation and is not expected to pose any problem.

8.3 General Services and Utilities

The only water required by the drying process is the cooling water taken from the circulating water system. Most of this water is returned and the rest is evaporated. All of the process steam supplied to the facility is returned as condensate.

Potable water for restrooms, faucets, and cleaning sinks could be supplied from the Milton R. Young Power Station or from the municipal water supply directly. A sewage collection system will also be required to support the potable water drains.

Building heat can be supplied either from the Milton R. Young Power Station, or from a separate drying facility heating system.

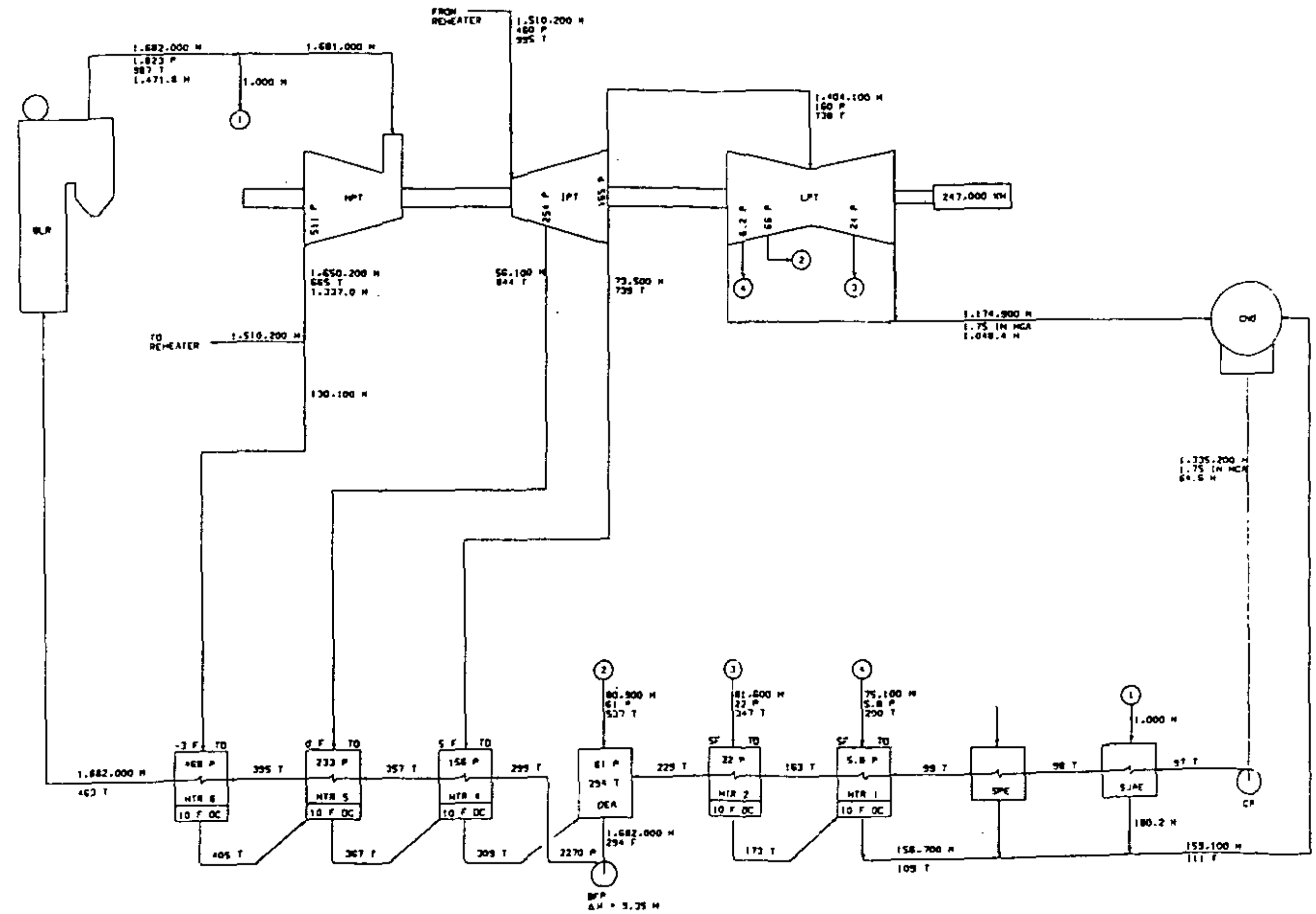


Site Layout
Figure 8-1

9.0 Milestone Schedule

A preliminary milestone schedule is included in Appendix B.

Appendix A
Heat Balances



LEGEND:

W = FLOWRATE, LB/H
P = PRESSURE, PSIA
T = TEMPERATURE, F
H = ENTHALPY, BTU/LB

* LEAKS ARE NOT SHOWN ON HEAT BALANCE

PERFORMANCE SUMMARY

NTO	= 247,000 KW
AUX	= 16,400 KW
NPO	= 230,600 KW
B.EFF	= 82.1%
HTWR	= 8,305 BTU/KWH
NPHR	= 10,835 BTU/KWH (HHV)

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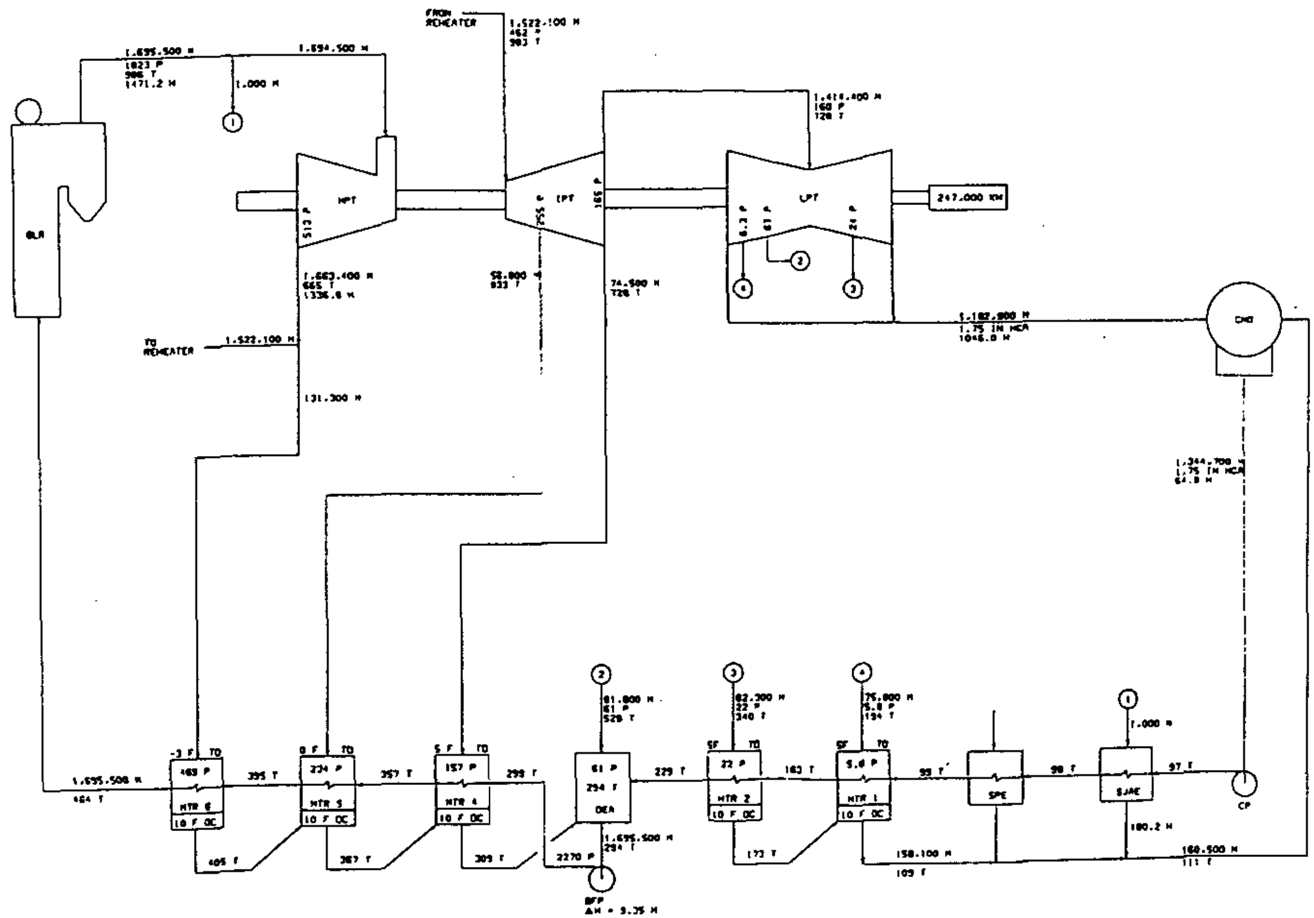
BLACK & VEATCH

ROSEBUD SYNCOAL PARTNERSHIP
MILTON R. YOUNG POWER STATION

HEAT BALANCE
UNIT 1 - 9150 CASE

PROJECT 24465-200-M1001 REV A



LEGEND:

W = FLOWRATE, LB/H

P = PRESSURE, PSIA

T = TEMPERATURE, F

H = ENTHALPY, BTU/LB

*LEAKS ARE NOT SHOWN ON HEAT BALANCE

PERFORMANCE SUMMARY

NTG = 247,000 KW

AUX = 16,400 KW

NPO = 230,600 KW

B.EFF = 84%

NTHR = 8,325 BTU/KWH

NPHR = 10,615 BTU/KWH (HHV)

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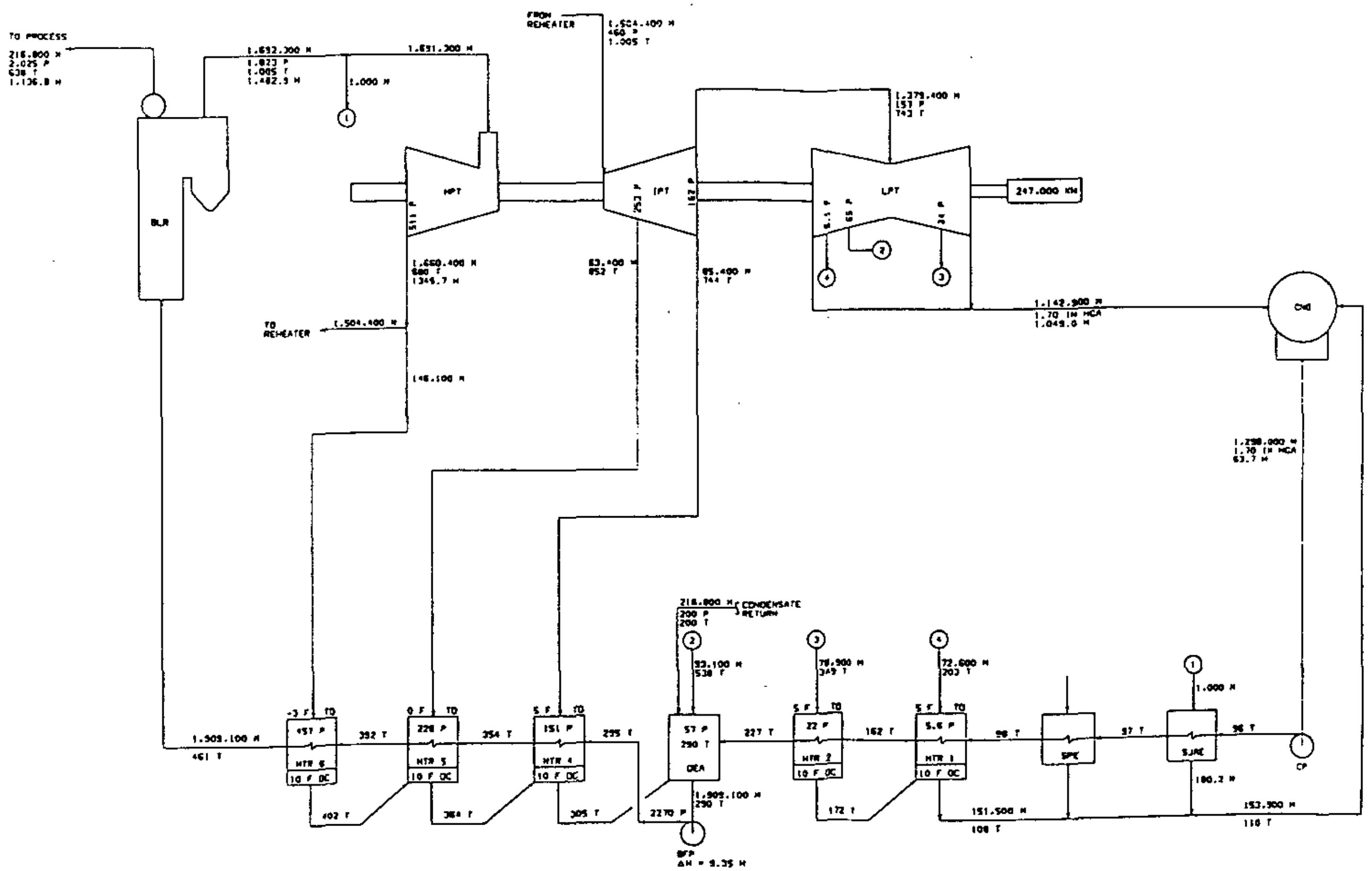
ROSEBUD SYNCOAL PARTNERSHIP
MILTON R. YOUNG POWER STATION

HEAT BALANCE
UNIT 1 - CASE B1

24465-200-M1002

REV A



LEGEND:

W = FLOWRATE, LB/H
P = PRESSURE, PSIA
T = TEMPERATURE, F
H = ENTHALPY, BTU/LB

*LEAKS ARE NOT SHOWN ON HEAT BALANCE

PERFORMANCE SUMMARY

NTO = 247,000 KW
AUX = 17,700 KW
NPO = 229,300 KW
B.EFF = 81.7%
NTHR = 9,075 BTU/KWH
NPHR = 11,965 BTU/KWH (HHV)
NTHR CHARGED TO POWER = 8,200 BTU/KWH
NPHR CHARGED TO POWER = 10,845 BTU/KWH (HHV)

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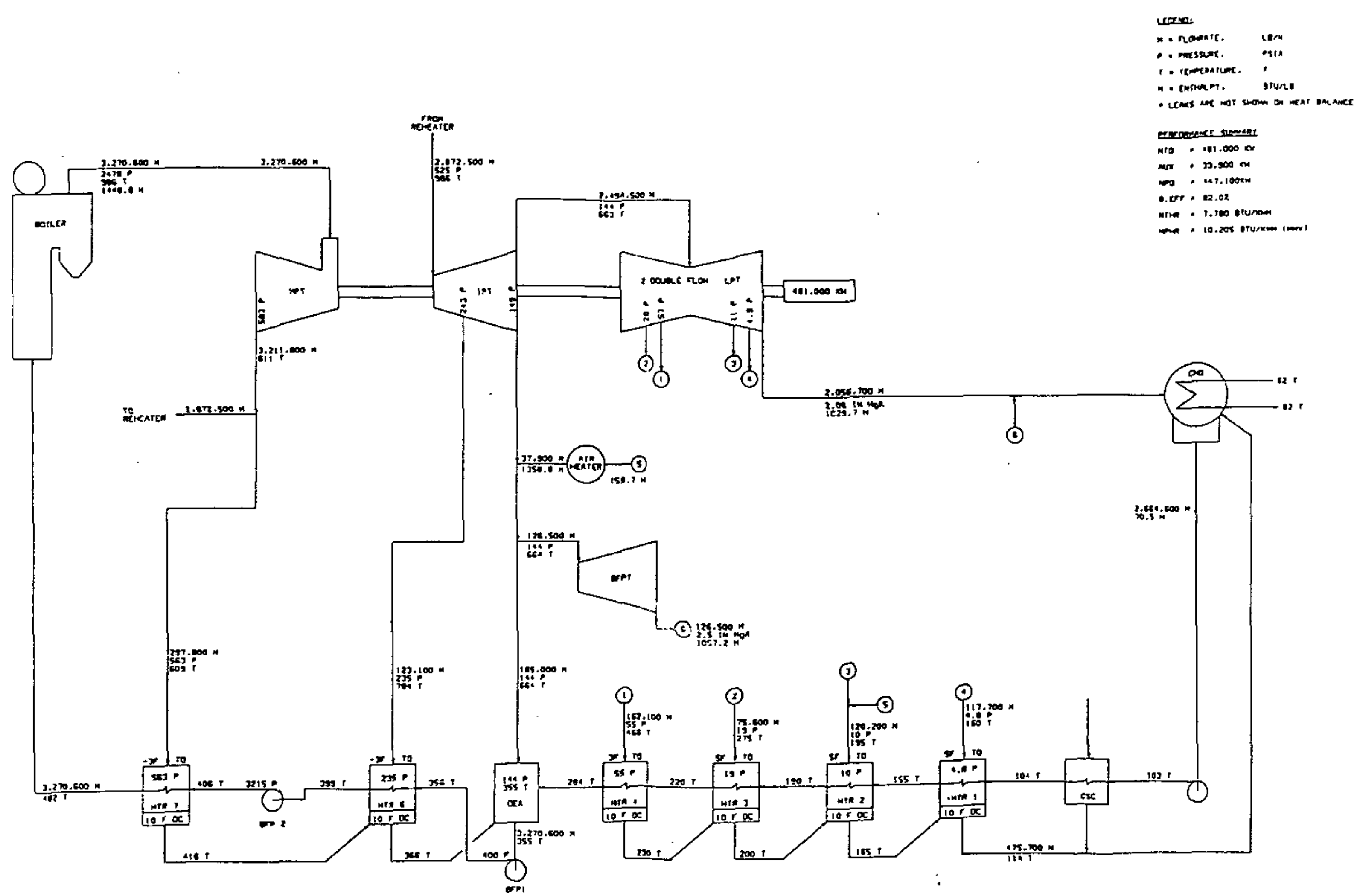
ROSEBUD SYNCOAL PARTNERSHIP
MILTON R. YOUNG POWER STATION

HEAT BALANCE
UNIT 1 - CFSC A1

PROJECT 24465-200-M1003 REV A



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ROSEBUD SYNCOAL PARTNERSHIP
MILTON R. YOUNG POWER STATION

HEAT BALANCE
UNIT 2 - BASE CASE

24465-200-M1008

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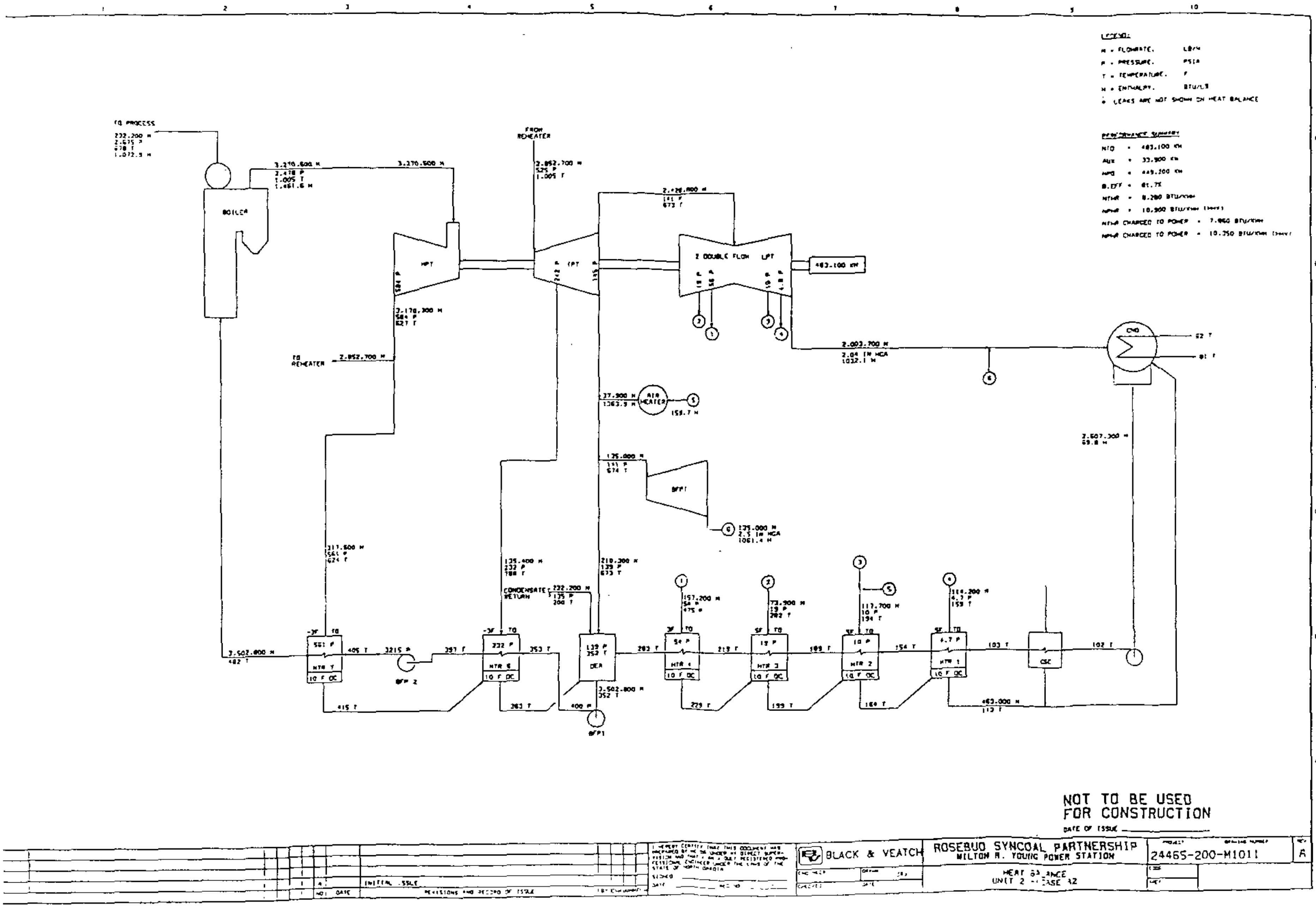
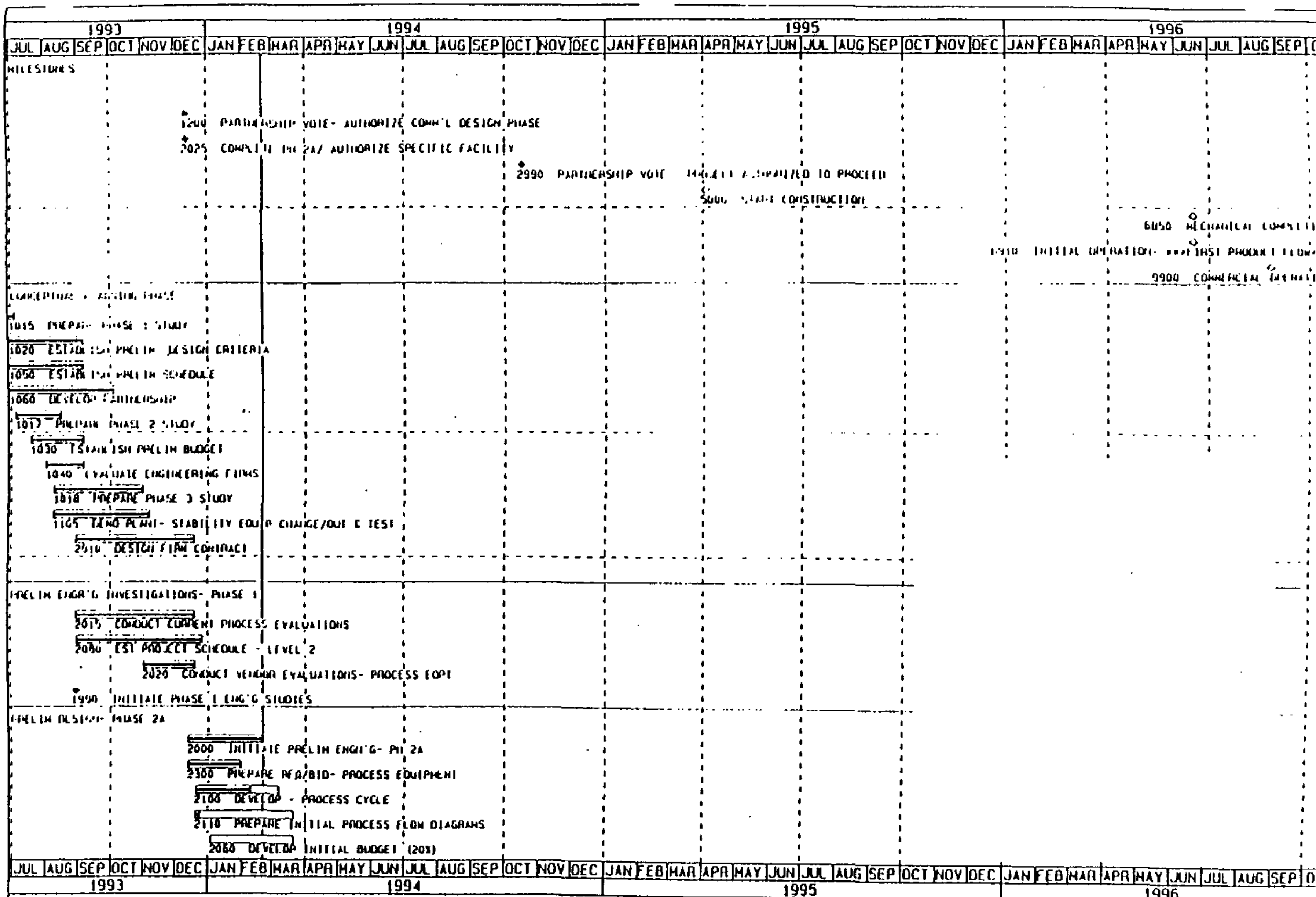
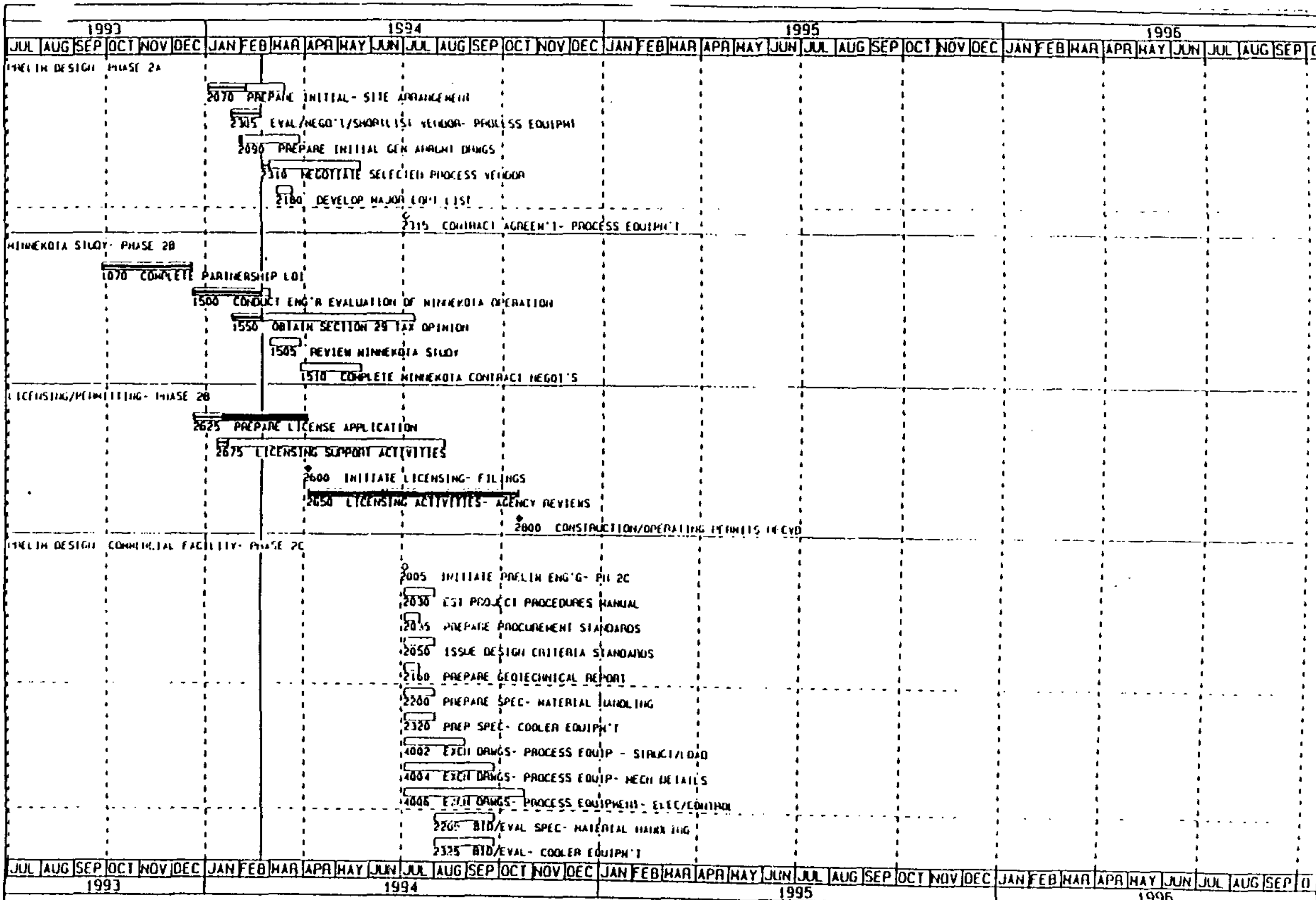


LEGEND:
M = FLOWRATE, LB/H
P = PRESSURE, PSIA
T = TEMPERATURE, F
H = ENTHALPY, BTU/LB
LEAKS ARE NOT SHOWN ON HEAT BALANCE
PERFORMANCE SUMMARY
AUX = 33,900 KW
TO PROCESS
BOILER
HPT
IPT
2 DOUBLE FLOW LPT
483,100 KW
FROM REHEATER
TO REHEATER
2,852,700 M
AIR HEATER
BFPT
CND
CSC
DEA
BFP 1
BFP 2
HTR 7
HTR 6
HTR 4
HTR 3
HTR 2
HTR 1
CONDENSATE RETURN
3,502,800 M
NOT TO BE USED
FOR CONSTRUCTION
DATE OF ISSUE
BLACK & VEATCH
ROSEBUD SYNCOAL PARTNERSHIP
MILTON R. YOUNG POWER STATION
24465-200-M1011
A
INITIAL ISSUE
REVISIONS AND RECORD OF ISSUE

Appendix B
Milestone Schedule



ROSEBUD SYNCOAL PARTNERSHIP
COMMERCIAL FACILITY- 2x100
PROJECT MANAGEMENT BARCHART REPORT

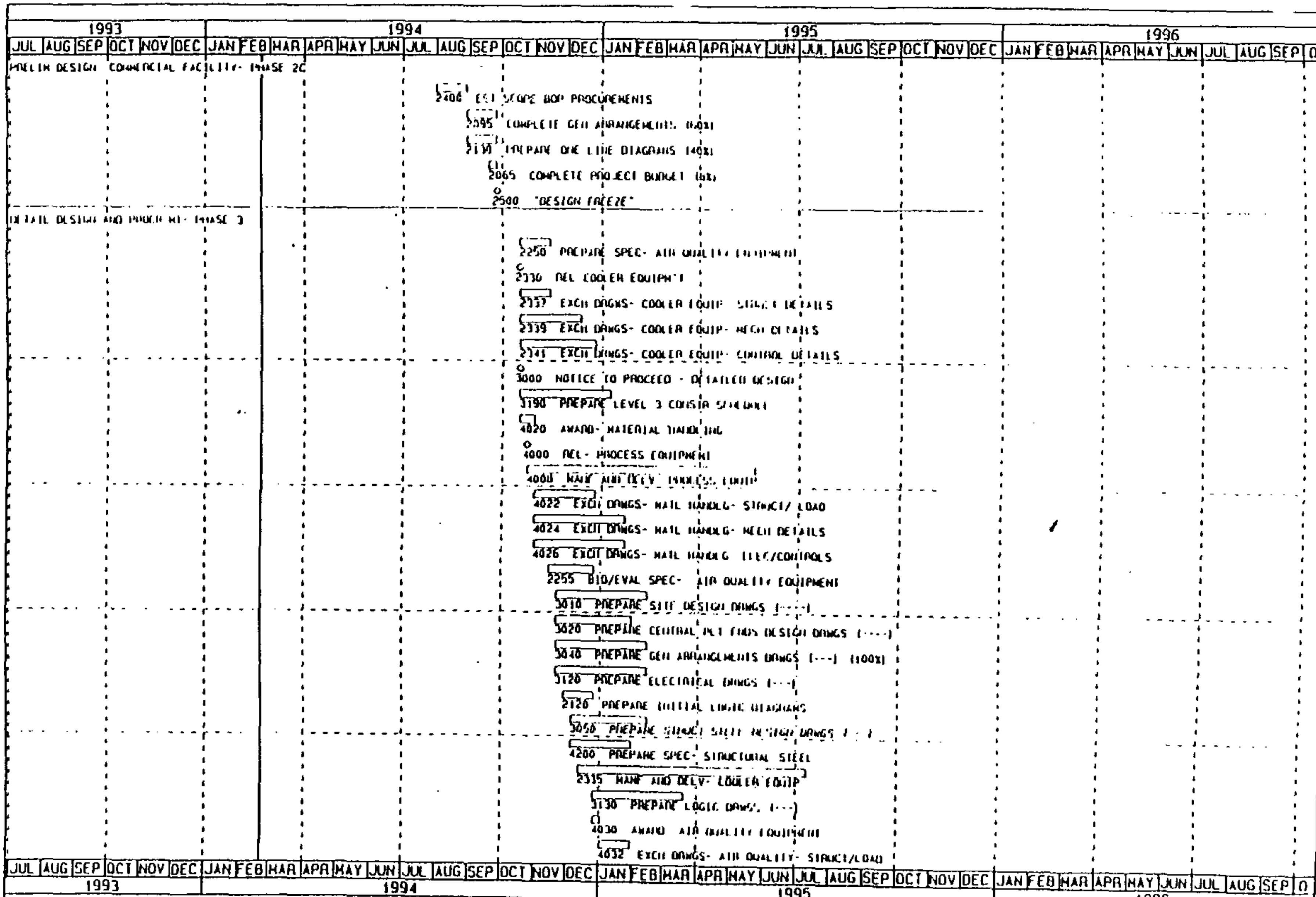


Plot Date 24FEB94
Data Date 21FEB94
Project Start 4JAN93
Project Finish 5JUN97

ROSEBUD SYNCOAL PARTNERSHIP
COMMERCIAL FACILITY- 2x100
PROJECT MANAGEMENT BARCHART REPORT

PRELIMINARY PROJECT SCHEDULE -02/21/94

Date | Revision | Checked | Approved

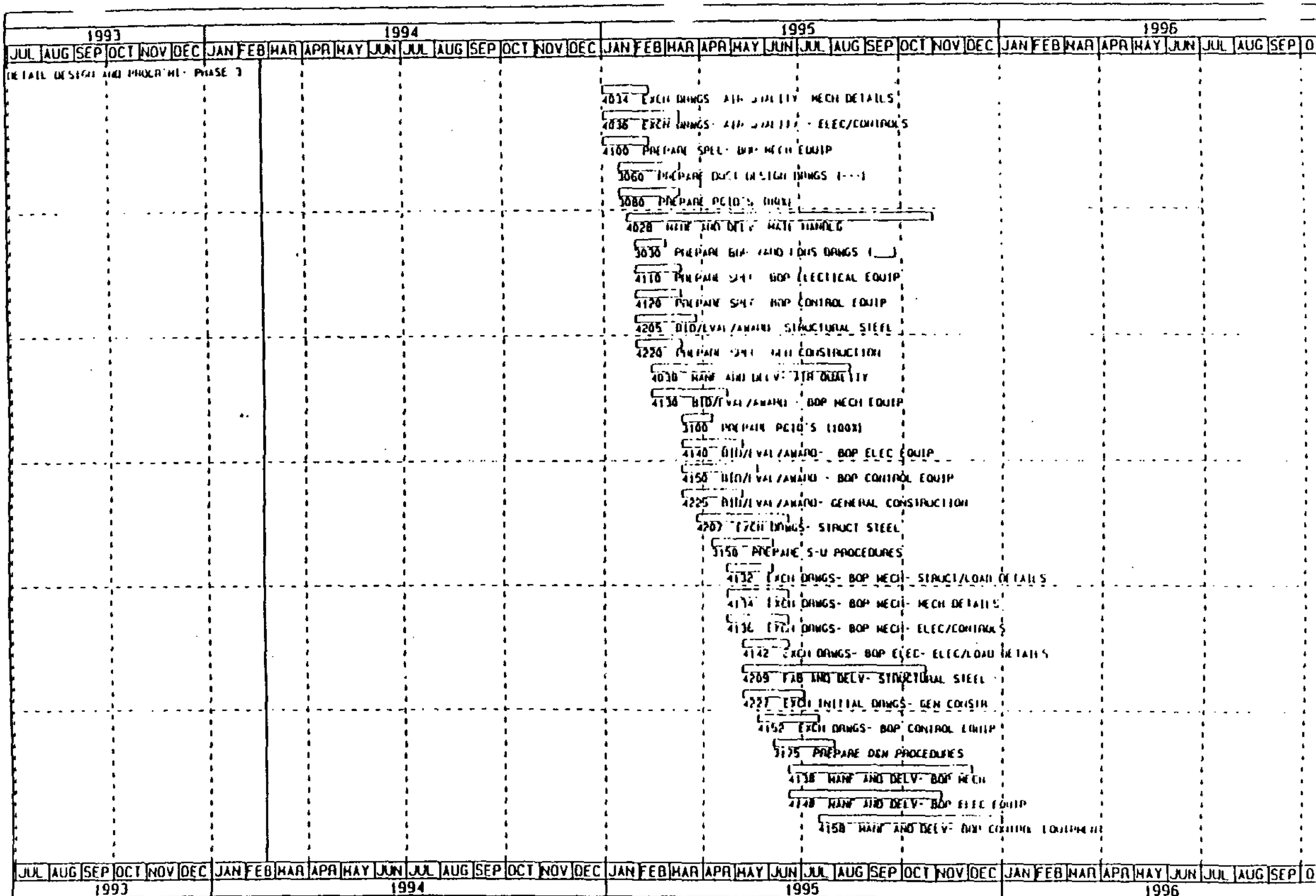


ROSEBUD SYNCOAL PARTNERSHIP
COMMERCIAL FACILITY- 2x100
PROJECT MANAGEMENT BARCHART REPORT

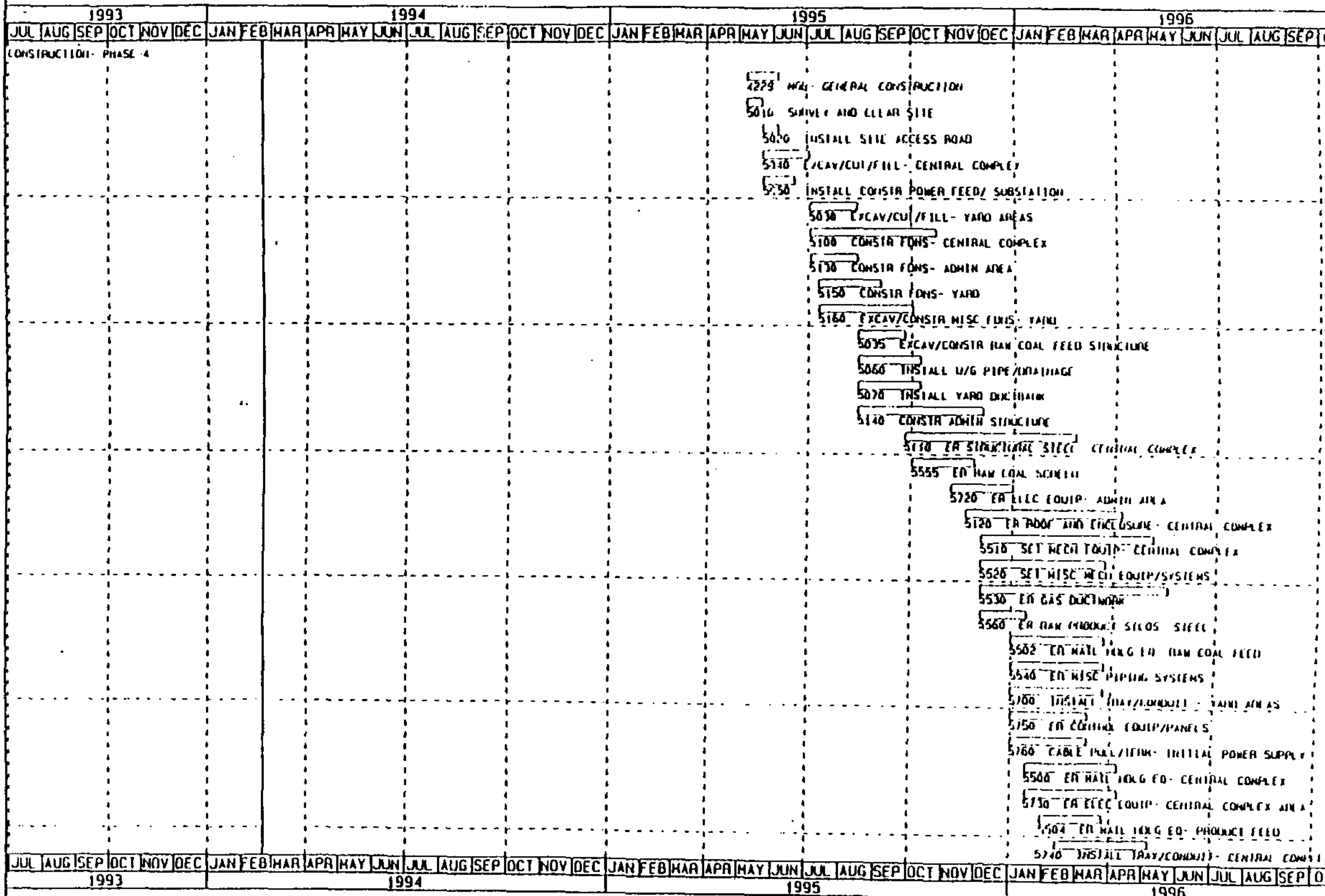
Plot Date	24FEB94	
Data Date	21FEB94	
Project Start	4JAN93	
Project Finish	30AUG97	

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

Date | Revision | Checked | Approved



ROSEBUD SYNCOAL PARTNERSHIP
COMMERCIAL FACILITY - 2x100
PROJECT MANAGEMENT BARCHART REPORT

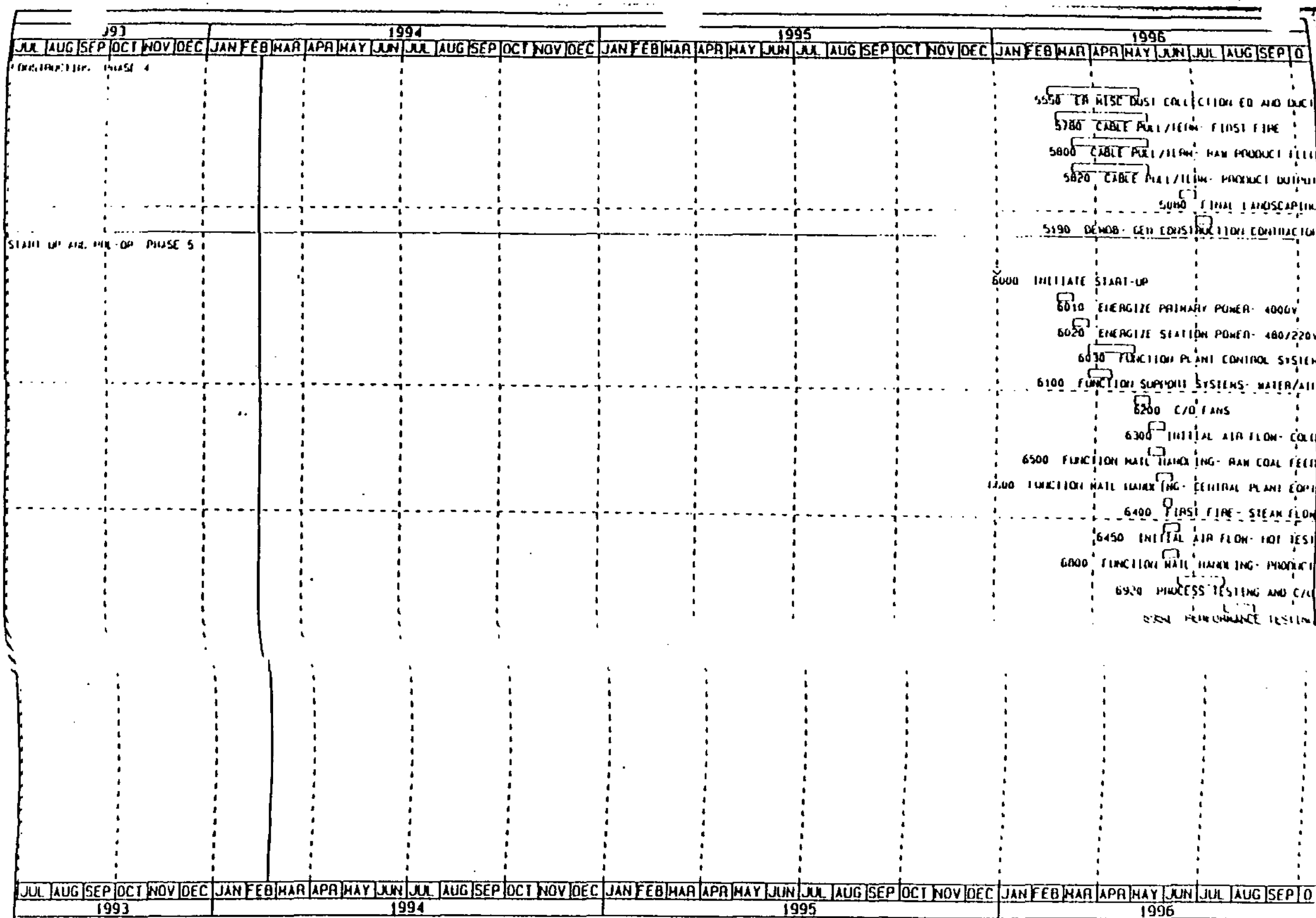


ROSEBUD SYNCOAL PARTNERSHIP
COMMERCIAL FACILITY- 2x100
PROJECT MANAGEMENT BARCHART REPORT

Plot Date
Data Date
Project Start
Project Finish

Primavera Systems, Inc.

Rev 3 PRELIMINARY PROJECT SCHEDULE
Date | Revision | Checked | Approved



Plot Date 24FEB94
Data Date 21FEB94
Project Start 4JUN93
Project Finish 5JAN97

ROSEBUD SYNCOAL PARTNERSHIP
COMMERCIAL FACILITY- 2x100
PROJECT MANAGEMENT BARCHART REPORT

Rev 1 PRELIMINARY PROJECT SCHEDULE - 02/21/94

Date	Revision	Checked	Approved

APPENDIX E

ENGINEERING CAPITAL COST ESTIMATE DETAIL

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
ENGINEERING & PERMITS			
Preconstruction Costs (Engineering, Premiums, etc)	$850,000		
Permits	$25,000		
Environmental Assessment			
Geotechnical Study			
Interconnect Design			
Site Topographic Survey			
Division 1		$875,000	$875,000
SITEWORK			
Demolition(3 foundations)	$0		
Dewatering	$16,700		
Relocate 2 Metal Buildings	$10,000		
Remove and Reinstall Building	$70,000		
Site Stripping	$0		
Site Prep and Grading	$0		
Site Excavation	$60,500		
Site Backfill Imported	$25,700		
Structural Excavation	$7,500		
Structural Backfill Imported	$26,400		
Disposal Of Excess Excavation on site	$29,000		
Caissons	$21,100		
Electrical Duct Bank & Trench	$0		
Utility Excavation (Obstruction) & Back Fill	$0		
Site Under Ground Piping	$0		
Storm Drains & Structures	$0		
Shoring	$0		
Erosion Control	$11,000		
Sewage system	$0		
Water Supply to Site	$0		
Gas Supply to Site	$0		
Waste Water Discharge	$0		
Fire Service Loop	$0		
Storm Retention Pond with Liner	$0		
Bio Filtration Swail	$0		
Access Road Improvement	$0		
Access Road Maintenance	$0		
Onsite Road Work for Construction	$0		
Onsite Road Base & Asphalt Paving	$0		
Gravel Surfacing	$5,400		
Curbs, Markings, etc.	$0		
Substation Fence & Gates	$3,000		
Power Plant Fencing & Gates	$0		
Landscaping	$0		
Division 2		$286,300	$1,161,300

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
CONCRETE WORK			
Cooler Foundation	$121,000		
Perimeter footings and grade beams	$125,400		
Int. Col Fdn's.	$48,400		
Blowers	$24,000		
Crushers			
Baghouse	$15,900		
Control MCC Room	$28,200		
Switchyard	$5,100		
Octagonal Fdn's	$14,300		
CONCRETE WORK (CONTINUED)			
Process Bldg	$130,800		
Misc.	$77,600		
Conv Galleries Caissons	$34,000		
Conv. Gallery Ftgs	$33,700		
Relocated bldg fdn Turbine parts Storage	$0		
Relocated building fdn's misc storage 2 each	$30,000		
Nitrogen System Pad	$50,000		
Division 3		$738,400	$1,899,700
MASONRY			
CMU Wall At Transformer	$9,000		
Control Room	$146,700		
Division 4		$155,700	$2,055,400
METALS			
Structural Steel	$1,218,900		
Misc Metals			
Anchor Bolts / Embeds			
Walkways/Catwalks @ CTG's	$245,100		
Piperacks/Pipeways			
Station Switchyard Steel	$25,000		
Install Bridge and Towers	$233,300		
Division 5		$1,722,300	$3,777,700
MOISTURE/THERMAL PROTECTION			
Siding	$590,000		
Roofing and Metal Decking	$97,600		
Louvers etc.	$25,000		
Building Insulation	$0		
Water Proofing	$0		
Gutters and Down Spouts	$2,700		
Penetrations	$6,000		

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION		COST	SUBTOTAL	CUMMULATIVE TOTAL
Siding and Roof Conveyor Bridge		$0		
	Division 7		$721,300	$4,499,000
DOORS & WINDOWS				
Hollow Mtl Doors,Frames		$1,100		
Hardware				
Windows, Sky Lights		$5,000		
Rollup Doors		$3,000		
	Division 8		$9,100	$4,508,100
FINISHES				
Gypsum Wallboard		$0		
Acoustical Ceilings		$0		
Carpet Floor Coverings		$0		
Resilient Floor Coverings		$0		
Plant Painting		$0		
Flashing		$0		
	Division 9		$0	$4,508,100
SPECIALTIES				
Toilet Partitions and Accessories		$0		
Signs & Pipe Markers		$0		
Lockers		$0		
Fire Protection Specialties		$0		
Louvers		$0		
	Division 10		$0	$4,508,100
PROCESS EQUIPMENT				
Pricing Supplied by : Eaton Metal Products				
Condensate Tank 250 psia at 500 F 10' x 6'		$59,400		
Reactor Flash Tank 2700 psia at 750 F 10' x 6'		$57,900		
Dryer Flash Tank 2700 psia at 750 F 10' x 6'		$24,700		
Add for freight		$2,000	$144,000	
Pricing Supplied by-- Stone& Webster				
Compressed Air Tank		$1,000		
Nitrogen Gas Receiver		$6,500		
Add for freight		$500	$8,000	
Pricing Supplied by ----Stone & Webster-------------				
TK-6304 Syncoal Plant Water Supply tank 3000 gal		$2,500		
Add for freight		$500	$3,000	

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
Pricing Supplied by --Eco---------------			
HX-3601 Dryer Heat Exchanger	$211,000		
HX-3602 Preheat Exchanger	$256,100		
HX-3603 Preheat Exchanger	$256,100		
HX-3611 Reactor Heat Exchanger	$292,000		
HX-3612 ReactorPre Heat Exchanger	$513,700		
Soot Blowers	$78,000		
Add for freight	$50,000	$1,656,900	
Supplied by Goulds			
Add for freight	$2,500		
PO-4001 Cooling Water pump A 1100 gpm	$7,300		
PO-4002 Cooling Water pump B 1100 gpm	$7,300		
PO-4005 Cooling tower Makeup pump 50 gpm	$3,200		
PO-4006 Cooling tower Makeup pump 50 gpm	$3,200		
PO-4021,22,23 Plant Water Supply pump 125 gpm	$6,400		
Booster pump for firewater	$10,000	$39,900	
Supplied by HTI			
Add for freight	$1,800		
PO-4003 Condensate pump 450 F at 1800 psia 55 gpm	$82,500		
PO-4004 Condensate pump 450 F at 1800 psia 55 gpm	$82,500		
Model LMV-311 316 SS w/ Mech Seal and Heat Exch			
and Gear Box incl explosion proof 2oo hp motor			
Delivery 18 weeks vertical inline		$166,800	
Supplied by Goulds			
Add for freight	$1,000		
PO-4011 Syncoal Building sump pump 200gpm	$5,700		
PO-4012 Syncoal Building sump pump 200gpm	$5,700	$12,400	
PROCESS EQUIPMENT (CONTINUED)			
Supplied by Kobelco			
Add for freight	$2,500		
AC-1101 Air Compressor 300 scfm rotary screw	$45,000		
AD-7301 Air Dryer -40			
model number ('knwodh) 331scfm at 125#			
receiver 400 gal	$1,200		
Add Z purge	$2,500		
TEFC motor adder	$800	$52,000	
Supplied by MT Industries Nitrogen,Inc.			
Add for freight	$0		
Nitrogen Gas Plant 500 scfm	$0	$0	

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
Supplied by --- Hawthorne Treating Systems			
Add for freight/ Vendor Rep	$5,000		
Packaged water treating (Filter)	$31,300	$36,300	
Supplied by FMC			
Add for freigtht	$20,000		
Add for vendor Rep Assistance/Start-up	$5,000		
Syncoal Cooler A & B	$1,125,000	$1,130,000	
Supplied by Marley			
Add for freigtht	$5,000		
Cooling Tower 15,000mm btus 1000 gpm flow rate	$32,100		
two cell cooling tower with reverse fans and basin heaters		$32,100	
Supplied by Wolf	$1,400,000		
DV-6901 Primary Coal Diverter			
CN-5401 Primary Infeed Belt Conveyor 48" wide by 280'			
BD Activated Bin Discharge			
CN-5405 Process Infeed Weigh Belt			
CN-5403 Process Infeed Belt Conveyor 24" wide by 60' ctrs			
DV-6902 Process Infeed Coal Diverter			
CG-1801 Coal Infeed Crusher			
CG-1802 Coal Infeed Crusher			
CN-5404 Crusher Discharge Belt Conveyor24" wide 42' ctrs			
BE-5301 Process Infeed Coal Bucket Elevator150'			
DD-7006 Cooler A Outfeed DD Valve			
DD-7007 Cooler B Outfeed DD Valve			
CN-5405 Cooler Discharge Belt Conveyor 24" wide 75' ctrs			
SN-2203 Syn Coal Product Screen			
CG-1803 Syncoal Product Crusher			
CN-5406 Syncoal Primary Belt Conveyor 42" wide			
BE-5302 Syncoal Bucket Elevator 150'			
DV-6906 Syncoal Storage Bin Diverter Valve			
Main Conveyor and Piping Gallery app 250' span			
Permanent Magnet			
Screen crusher support ,Access Platform			
Sampling System	$13,100		
Engineering and Site Trip	$262,400		
Start up Instructions	$0		
Freight	$18,000		
add for perlons	$32,100	$1,725,600	

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
Pneumatic System Supplied by (SMOOT)	$1,080,000		
Add for freigtht			
Add for start up vendor rep assistance		$1,080,000	
Dust Collection System			
Design and Pricing Supplied by Stone & Webster			
Lignite dust collection system	$100,000		
Syncoal dust collection system	$100,000		
Add for freigtht	$25,000		
Add for start up vendor rep assistance	$24,000		
Bin vent filters	$30,000	$279,000	
Reactor and Dryer Supplied by Carrier	$3,490,000		
Add for freight	$55,000		
Add for start up vendor rep assistance	$24,000		
FB-7201 Fluid Bed Dryer			
CY-1910 Dryer Multi clone A			
CY-1920 Dryer Multi clone B			
SC-5601 Dryer Mulit clone A Screw Conveyor			
SC-5602 Dryer Mulit clone B Screw Conveyor			
Reactor Supplied by Carrier			
FB-7202 Fluid Bed Reactor			
CY-1930 Reactor Multi-clone A			
CY- 1940 Reactor Multi-clone B			
SC-5603 Reactor Multi-clone A screw Conveyor			
SC-5604 Reactor Multi-clone B screw Conveyor			
DV-6905 Cooler infeed Diverter Valve		$3,569,000	
Double dump valves - Platco	$175,000		
freight	$5,000		
Blow out Panels	$100,000	$280,000	
Supplied by Anderson Steel Supply			
Add for freight			
BN-6002 1800 ton Coal Infeed Surge Bin	$337,300		
BN-6010 200 ton Syncoal Storage Bin	$70,500		
BN- 6020 350 ton Syncoal Storage Bin	$99,400		
BN- 22 ton Syncoal Bin to feed Lift tubes	$115,400	$622,600	
Pricing Supplied by GPM, Inc.			
Add for freight	$20,000		
Add for start up vendor rep assistance	$24,000		
FN-1301 Dryer Fluidization Fan	$267,900		
FN-1302 Reactor Fluidization Fan	$278,200	$590,100	
Process Equipment		$11,452,700	

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
PROCESS ELECTRICAL			
STEP DOWN XFMR 10MVA 69KV - 5KV	$145,000		
SUS XFMR SECTION 5KV-480V			
PLANT 5KV SWGR \ MVC (8-SECTION)	$149,000		
SUS 480V PLANT (4-SECTION)	$152,000		
MCC #1 (8-SECTION)			
MCC #2 (8-SECTION)			
MCC #3 (8-SECTION)			
MCC #4 (10 SECTION)			
PROCESS ELECTRICAL(CONTINUED)			
MOTOR CONTROL CENTERS		$165,000	
I/O CABINETS			
PLC CABINETS			
ENGINEERS WORKSTATION			
OPERATORS WORKSTATION			
PRINTERS			
INTERCONNECT CABLING			
PCS SYSTEM		$413,000	
VERT BREAK DISCONNECT MANUAL			
VERT BREAK DISCONNECT MANUAL	$12,000		
ARRESTORS	$4,500		
POST INSULATORS	$7,500		
5KV NON-SEG BUSDUCT 150LF			
5KV NON-SEG BUSDUCT 50LF	$12,500		
30KVA UPS SYSTEM			
10KVA UPS SYSTEM	$10,000		
BATTERIES AND RACK			
BATTERY CHARGER			
SUBSTATION RELAYING \ METERING	$39,600		
STEAM METERING			
INSTRUMENTS	$465,300		
CONTROL VALVES	$134,500		
Process Electrical		$1,131,900	
Division 11		$12,584,600	$17,092,700
FURNISHINGS			
Lab/Office/Control Room Furnishings	$0		
Division 12		$0	$17,092,700
SPECIAL CONSTRUCTION			
Guard Services			
Gas Compressor Building			
Plant Substation Relay Room			
Shop or Warehouse			
Division 13		$0	$17,092,700

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

SPECIAL EQUIPMENT				
Overhead Bridge Crane				
Maintenance Hoist				
Scaffold Crew		$0		
Small Tools and Consumables Electrical		$0		
Elevators				
Third Party Rentals Electrical		$0		
	Division 14		$0	$17,092,700
MECHANICAL WORK				
Painting		$65,000		
Insulation		$886,800		
Mechanical Erection Engineered Equip.		$1,255,700		
Mechanical Demolition/ Civil		$74,200		
Mechanical Piping		$2,400,000		
Mechanical Specialties		$0		
Chrome Piping Main Steam		$0		
Equipment/rental ,Small tools, Scaffolding		$0		
Subcontract Profit/ Margin		$0		
MECHANICAL WORK (CONTINUED)				
Mechanical Overheads		$0		
Piping Materials		$0		
Expansion Joints		$738,000		
	Division 15		$5,419,700	$22,512,400
ELECTRICAL WORK				
Temporary Power		$53,000		
Electrical Civil		$73,300		
Grounding		$78,800		
Lighting		$191,750		
Conduit		$834,400		
Cable Tray		$165,300		
Wire Cable		$1,106,100		
Equipment		$0		
69 kV Transmission Line		$250,000		
Subcontracts		$0		
Lightning Protection		$55,000		
Additional Heat Tracing		$50,000		
INSTRUMENTATION				
Instrumentation		$100,000		
	Division 16		$2,957,650	
	Total Direct Cost			$25,470,050

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
DIRECT COST			$25,470,050
INDIRECT COST - SUBCONTRACTOR			
DIVISION 2	$73,800		
DIVISION 3	$190,300		
DIVISION 5	$444,000		
DIVISION 15	$1,397,100		
DIVISION 16	$762,400		
PROJECT MANAGEMENT - WSC	$1,600,000		
CONSTRUCTION SUPPORT SERVCES	$0		
CONSTRUCTION EXPEDITING	$0		
EXPORT DUTIES	$0		
IMPORT DUTIES	$0		
TAX ON PERMANENT ENGINEERED EQUIPMENT	$0		
TAX ON PERMANENT MATERIALS	$0		
SITE SPECIFIC TAX ON CONSUMABLES	$0		
E &O INSURANCE	$0		
ENGINEERING - SWEC	$2,400,000		
ENGINEERING - UNIFIELD			
Indirect Costs		$6,867,600	$32,337,650
CONTINGENCY	$2,263,636		
WSC PROFIT	$1,730,064	$3,993,700	
TOTAL CONTRACT PRICE			$36,331,350
STARTUP & O&M			
Startup Utilities			
Startup Craft Labor	$199,815		
Start-up Spare Parts	$25,000		
Spare Parts Allocation for one Year			
Operator Training	$20,000		
Chemicals	$5,000		
Lube Oil	$5,000		
Mfgr's Reps			
Casual Overtime	$48,906		
Oil & Chemical Disposal			
Startup/O & M		$303,721	
ENGINEEERING START-UP PROCED.	$320,000		
TOTAL STARTUP COSTS		$623,721	
BUILDERS RISK	$150,000		
Pre Construction Cost			
PAYMENT AND PERFORMANCE BOND			
Mgmt Overhead			
Permits			
Preoperational Costs			

SYNCOAL REFERENCE PLANT COST ESTIMATE
1997 U.S. $

DESCRIPTION	COST	SUBTOTAL	CUMMULATIVE TOTAL
Spare Parts & Inventory	$125,000		
Developers Fee	$1,000,000		
Financing Fee	$229,380		
SUBTOTAL PROJECT OWNERS COSTS		$2,128,101	
TOTAL CAPITAL EXPENDITURES			$38,459,451